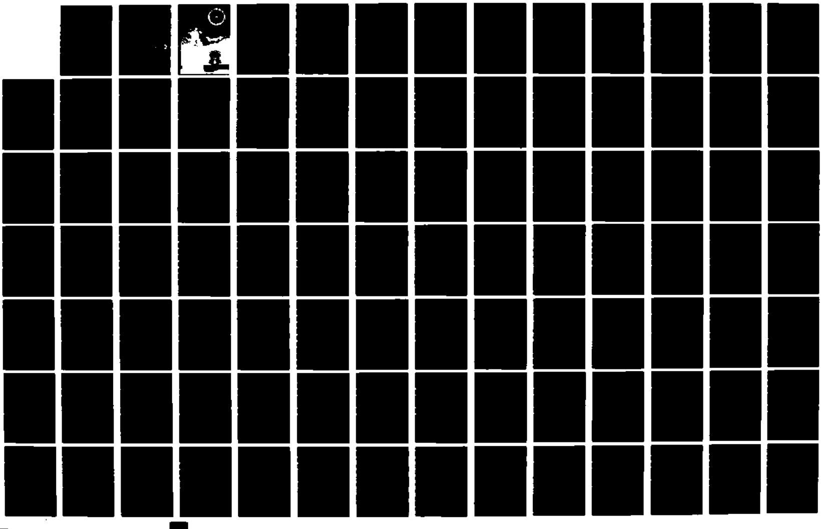
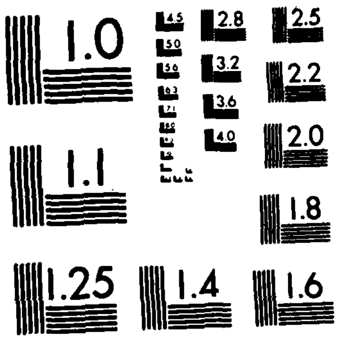
AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76

1/7

UNCLASSIFIED F/G 15/5 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER ③ / 2. GOVT ACCESSION NO. A128 657	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Fifth Annual Department of Defense Procurement Research Symposium	5. TYPE OF REPORT & PERIOD COVERED Final - 1976
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey CA	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS AFBRMC/RDCB Wright-Patterson afB OH 45433	12. REPORT DATE Nov 76
	13. NUMBER OF PAGES 404
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for public release; distribution unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Research Management	Grants	Commercial Products
Acquisition	Competition	Reliability
Procurement	Technology	Maintainability
Proceedings	Contract Incentives	Acquisition Strategy

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The fifth Annual DOD Procurement Research Symposium was held 17-19 November 1976 at Monterey, California. Presentations covered the following areas: research candidate evaluation, acquisition research management, grants, competition, commercial products, technology incentives, reliability and maintainability, socio-economic considerations, acquisition strategy and PROFIT 76.

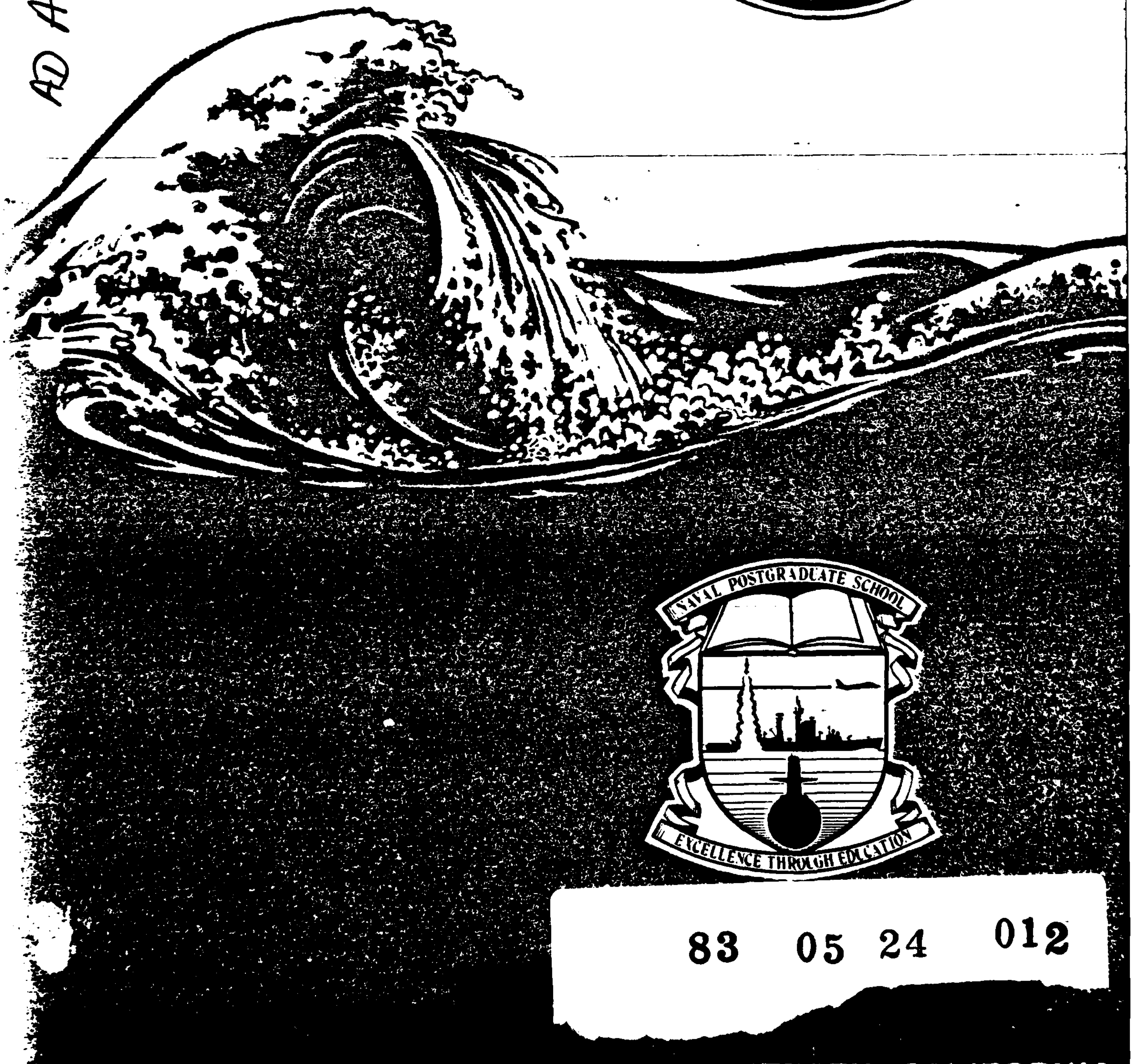
DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AD A128657

The Fifth Annual DEPARTMENT of DEFENSE PROCUREMENT RESEARCH SYMPOSIUM at the Naval Postgraduate School

17-19 November, 1976



83 05 24 012

NAVAL POSTGRADUATE SCHOOL MONTEREY, CALIFORNIA

TABLE OF CONTENTS

AGENDA

FIFTH ANNUAL DEPARTMENT OF DEFENSE

PROCUREMENT RESEARCH SYMPOSIUM

17 - 19 November 1976

Naval Postgraduate School
Monterey, California

AGENDA

TUESDAY, 16 November

5:00 - 7:00 p.m. Registration, Lobby, Hilton Resort Inn

7:00 - 8:00 p.m. No host cocktail party, Ballroom, Hilton Resort Inn

WEDNESDAY, 17 November

8:00 - 9:00 a.m. Late Registration, Coffee & Donuts, Lobby/Patio, Ingersoll Hall

9:00 - 10:00 a.m. SYMPOSIUM OPENING, Ingersoll 122

WELCOME

RADM Isham Linder, Superintendent Naval Postgraduate School

INTRODUCTORY REMARKS

Mr. John Kunsemiller, Chairman DOD Procurement Research Coordinating Committee

10:00 - 10:15 a.m. REFRESHMENTS, Lobby/Patio, Ingersoll Hall

10:15 - 12:15 p.m. GENERAL SESSION I Ingersoll 122

"Evaluating Research Candidates and Validating Research Products"

Co-Chairman,

Dr. Paul Arvis - Director, Army Procurement Research Office

LtCol Dan Strayer - Air Force Business Research Management Center

Panel Members,

Professor Robert Judson - Adjunct Professor Naval Postgraduate School

Dr. William E. Souder - Associate Professor, Director of Technology Management Studies Group, University of Pittsburg

12:30 - 2:00 p.m. LUNCH - La Prado Room, Herrmann Hall

Speaker - Mr. Jerome Stolarow, Deputy Director Procurement and Systems Acquisition - GAO

"Need for Management Research on Acquisition Problems"

2:00 - 3:15 p.m. CONCURRENT SESSION I

Participants may attend either of the sessions which will be held in designated rooms. Opportunities for splitting attendance may come after paper presentations or the refreshment break.

WORKING GROUP A - Ingersoll 271

"Grants"

Chairman,
Mr. Susumu Uyeda - Budget Review Division
Office of Management and Budget

Panel Members,

Mr. Mathias Lasker - Director
Grants Policy & Regulation Development
Dept. of Health, Education and Welfare

Mr. John V. Walsh - Director of Procurement
Office of Scientific Research

WORKING GROUP B - Ingersoll 122

"Competition"

Chairman,
Mr. Les Fettig - Chief Counsel and Staff Director
Subcommittee on Federal Spending Practices

Panel Members,

Dr. Richard Lorette - Assoc. Prof., Systems Management Dept.
University of Southern California

Mr. Robert Shearer - Vice President, Contract Management, Education, and Research Institute

Mr. John A. Muller - Deputy Director Procurement and Production Directorate
U. S. Army Missile Command

Mr. Donald Templeman - Chief, Technology Assistance Division, Small Business Administration

3:15 - 3:30 p.m. REFRESHMENTS, Lobby/Patio, Ingersoll Hall

3:30 - 5:00 p.m. CONCURRENT SESSION I (cont'd.)

WORKING GROUP B (cont'd.)

WORKING GROUP C - Ingersoll 271

"Commercial Products"

Chairman,

Capt Richard Hampton USAF - Procurement Material Staff Officer Defense Logistics Agency

Panel Members,

Mr. Don Sowle - President, Don Sowle Associates, In.

Mr. Leroy Haugh - Assistant Administrator for Regulations, Office of Federal Procurement Policy

Mr. Fred Bunke - Assistant Commissioner for Procurement, General Services Administration

5:00 - 6:00 p.m. No host cocktail party, La Novia Room, Herrmann Hall

Evening Free

THURSDAY, 18 November

8:00 - 8:30 a.m. REFRESHMENTS, Coffee & Donuts, Lobby/Patio, Ingersoll Hall

8:30 - 10:15 a.m. CONCURRENT SESSION II

WORKING GROUP D - Ingersoll 122

"Technology Incentives"

Chairman,

Mr. Joseph Berke - Chairman, Procurement Programs Experimental Technology Incentives Program

Panel Members,

Mr. Charles Hulick - Procurement Programs, Experimental Technology Incentives Program, U. S. Dept. of Commerce

Maj Gregory Hildebrandt - Department of Economics, Geography and Management U. S. Air Force Academy

Dr. James B. McNallan - Market Research Specialist General Services Administration

8:30 - 10:15 a.m. Concurrent Session II (cont'd.)

WORKING GROUP E - Ingersoll 271

"Reliability & Maintainability Issues"

Chairman,
Capt Robert Tripp - Management Science Office Headquarters, Air Force Logistics Command, Wright-Patterson AFB

Panel Members,

Mr. Perry C. Stewart - Director of Concepts & Analysis, AFALD Wright-Patterson AFB

Mr. Martin Meth - Directorate of Acquisition & Support Planning, OASD (I&L)

LtCol Martin D. Martin - Assoc. Prof. Air Force Institute of Technology

Mr. Ralph P. Wilcox - Manager, Product Support Department, Instrument Division, Lear Siegler, Inc.

Mr. William R. Leak - Quality Assurance Engineer, DCAS, Van Nuys

10:15 - 10:30 a.m. REFRESHMENTS, Lobby/Patio, Ingersoll Hall

10:30 - 11:30 a.m. CONCURRENT SESSION II (cont'd.)

WORKING GROUP E (cont'd.)

WORKING GROUP F - Ingersoll 122

"Socio-Economic Impacts on Procurement"

Chairman,
Mr. James Cisco - Executive Director, Contract Employment Compliances, Alexandria, Virginia

Panel Members,

Mr. Fred Helwig - Procurement Analyst Army Procurement Research Office

11:45 - 1:30 p.m. LUNCH - La Prado Room, Herrmann Hall

Symposium Agenda

1:30 - 2:45 p.m. GENERAL SESSION II - Ingersoll 122

"Reconciling Organizational Interest in Procurement Research"

Chairman,
Mr. Leroy Haugh - Assistant Administrator for Regulations Office of Federal Procurement Policy

Panel Members,

Mr. John Kunsemiller - Director, Contract Administration and Support, Office of the Assistant Secretary of Defense (I&L)

Mr. Robert Lauck - American Law Division, Congressional Research Service, Library of Congress

Mr. W. Gregor MacFarlan - President, Sterling Institute

Mr. Andrew B. McConnell - Assistant Director, PSAD, General Procurement Subdivision, GAO

2:45 - 3:00 p.m. REFRESHMENTS, Lobby/Patio, Ingersoll Hall

3:00 - 5:00 p.m. GENERAL SESSION III - Ingersoll 122

"Acquisition Strategy Planning"

Chairman,
Mr. Mort Labovitz - Directorate of Weapons Systems Procurement OASD (I&L)

Panel Members,

Mr. Robert Stohlman - Assistant for Materiel Acquisition OASA (I&L)

Mr. Robert Williams - Chief, Test and Evaluation Group, Army Procurement Research Office

CDR Charles W. Ryland - Branch Head, Acquisition Programs, Systems Acquisition Division Headquarters Naval Material Command

LtCol Ronald L. Bulmer - Systems Procurement Staff Officer Headquarters USAF

6:00 - 7:00 p.m. SOCIAL HOUR - Ballroom - Herrmann Hall

7:00 - 9:00 p.m. BANQUET - Ballroom - Herrmann Hall

Speaker - RADM Leroy E. Hopkins, SC, USN
Deputy Commander for Contracts, Naval Sea Systems Command

Symposium Agenda

FRIDAY, 19 November

8:00 - 8:30 a.m. REFRESHMENTS, Coffee & Donuts, Lobby/Patio, Ingersoll Hall

8:30 - 10:30 a.m. CONCURRENT SESSION III

WORKING GROUP G - Ingersoll 271

"Major Shipbuilding Systems"

Chairman,
CDR Charles Piersall - Headquarters Naval Material Command

Panel Members,

Dr. F. A. P. Frisch - Naval Seas Systems Command

CDR Arthur C. Meiners - Naval Sea Systems Command

Dr. Alfred Feiler - School of Engineering & Applied Science University of California, Los Angeles

WORKING GROUP H - Ingersoll 122

"Profit 76 - Research Lessons Learned"

Chairman,
Col Charles J. Elliott USAF - Director for Contract Finance and Deputy Director of Profit '76

10:30 - 10:45 a.m. REFRESHMENTS, Lobby/Patio, Ingersoll Hall

10:45 - 12:00 a.m. GENERAL SESSION IV - Ingersoll 122

"Symposium Summary and Closing Remarks"

Chairman,
Mr. John Kunsemiller - Director, Contract Administration and Support, Office of the Assistant Secretary of Defense (I&L)

AGENDA

- SYMPOSIUM AGENDA

- RESEARCH PAPERS OF INTEREST

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER USAFA-TR-76-6	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A CONCEPTUAL MODEL FOR EVALUATING CONTRACTOR MANAGEMENT DURING SOURCE SELECTION		5. TYPE OF REPORT & PERIOD COVERED FINAL REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Lt Col F. Theodore Helmer Maj Robert L. Taylor		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Economics, Geography and Management United States Air Force Academy, Colorado 80840		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DFEGM USAF Academy, Colorado 80840		12. REPORT DATE MARCH 1976
		13. NUMBER OF PAGES 50
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Source Selection
Management Evaluation
Procurement

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides the reader with a conceptual model for evaluating a contractor's management potential during source selection. The model is not a definitive outline of what must be done; rather, a discussion of a number of the variables that ought to be considered. The reader can then include only those variables most relevant to the task at hand. The model, then, should be viewed as a thought triggering device for source selection panels to define and structure contractor management evaluation during the source selection process. The evaluation of contractor management is divided into three major

20. ABSTRACT (Cont'd)

functional areas: planning, organizing, and controlling. A checklist of variables under each topic is included in the report, with examples of a numerical scoring system, a color-coded evaluation system, and a descriptive adjective evaluation system. The report concludes with a detailed example of a complete source selection numerical scoring system, including technical, cost, management, quality, reliability, experience, facilities, and contract evaluations. This report should be invaluable to organizations entering into source selection.

TABLE OF CONTENTS

I. Background

The primary formal objective of the source selection process is to carefully and equitably evaluate each contractor's proposal to select that contractor who will best meet the technical performance, schedule, and cost objectives of the needed system. The importance of this process cannot be overstated, for the selection of the major system or subsystem contractor could well be the single most momentous decision in the management of the program. It is imperative, then, that the buying organization insist on a rigorous selection of contractors by structured (and, ideally, objective) standards, and that the same rigor be applied to contractor management as well as to the technical and cost parameters.

During source selection, competing contractors are evaluated on a number of variables: technical capabilities, cost/price estimates, quality control, reliability, facilities, proposed contract, related experience, capacity to manage the program, and other factors such as test capability and performance requirements. Each variable is weighted according to its importance in the program being considered. Thus, technical capability might be weighted most heavily in a developmental procurement while quality and reliability might well be the most important factors in a follow-on buy or production contract. Most often, technical parameters are specific in detail as are cost/price, quality and reliability. Each of these areas is usually reviewed in minute detail by teams of experts drawn from the buyer's organization. At the same time, management capabilities are left to the subjective judgment of individuals assigned to the management evaluation team. Our experience is that little guidance is available to this group in the formal source selection process.

An analysis of source selection procedures in a large-scale Air Force procurement verified that management capabilities were evaluated but not with the elaborate structure and detail of the technical and cost evaluations. In other procurements studied during the past two years, we found that management criteria were rarely specified in sufficient detail nor were the same systematic evaluations that are employed for the technical and cost portions of the proposal applied to contractor management capabilities. Subjectivity and inability to quantify were the reasons most often given in source selection procedures to justify an unstructured consideration of a contractor's management capabilities. A thorough review of the literature in this area indicates that there is no structured technique defined for this important evaluation. At the same time, we do not necessarily agree with Air Force Manual 70-6, that "it is rarely necessary for evaluation purposes to require extensive information in management systems."

In a recent unpublished Air Force Systems Command survey, industry respondents gave the Air Force a low rating on its management assessment ability. Contractors felt that evaluation capability was questionable (too low a level in terms of grade, experience, and ability) and that performance should be emphasized rather than "wiring diagrams and brochuresmanship." While three out of fourteen contractors felt the evaluations to be useful in source selection, only one thought the award would be decided on this factor. Five of the fourteen felt that management proposals were a waste of time and resources; being "square fillers" or "cut and paste exercises." Surveys such as this amplify the need for a much better evaluation system for reviewing a contractor's management.

The major concern of this report is to provide the reader with a conceptual model for evaluating a contractor's management potential. Nothing in this discussion should be construed to be a definitive outline of what must be done; rather, a discussion of a number of the variables that ought be considered. The reader can then include only those variables most relevant to the task at hand.

In an earlier draft of this report, we spent a great deal of time developing a quantitative model where weights were assigned and variables relating to the management potential of the firm were scored. Reviewers were overly concerned with the idea of mathematically measuring a contractor's or subcontractor's managerial potential and a number of critiques indicated a rejection of any kind of subjective evaluation scoring. We do not necessarily agree with this position. Mathematical models of subjective judgment have been discussed in management literature at length. In fact, a whole branch of statistics has been developed to deal with the concept of assessing subjective probabilities. Nonetheless, we will emphasize in this report those elements of management potential that should be considered in the source selection process and we will present mathematical scoring models only as examples of how a source selection board might weigh the management variables in the total selection process. Regardless of how a contractor's management potential is quantified, either by mathematical scoring as we propose, by red-flagging unacceptable deviations, or by a color-coding system of red, yellow and green, the fact remains that certain variables must be considered. This model suggests those variables which we have found to be both universal and critical to any complex procurement.

In sum, our conceptual model should be viewed as a thought triggering device for source selection panels to define and structure contractor management evaluation during the source selection process. This model could be used by a variety of source selection groups in the Department of Defense as well as by prime contractors selecting major subcontractors. It is the substance and not the method we believe to be important.

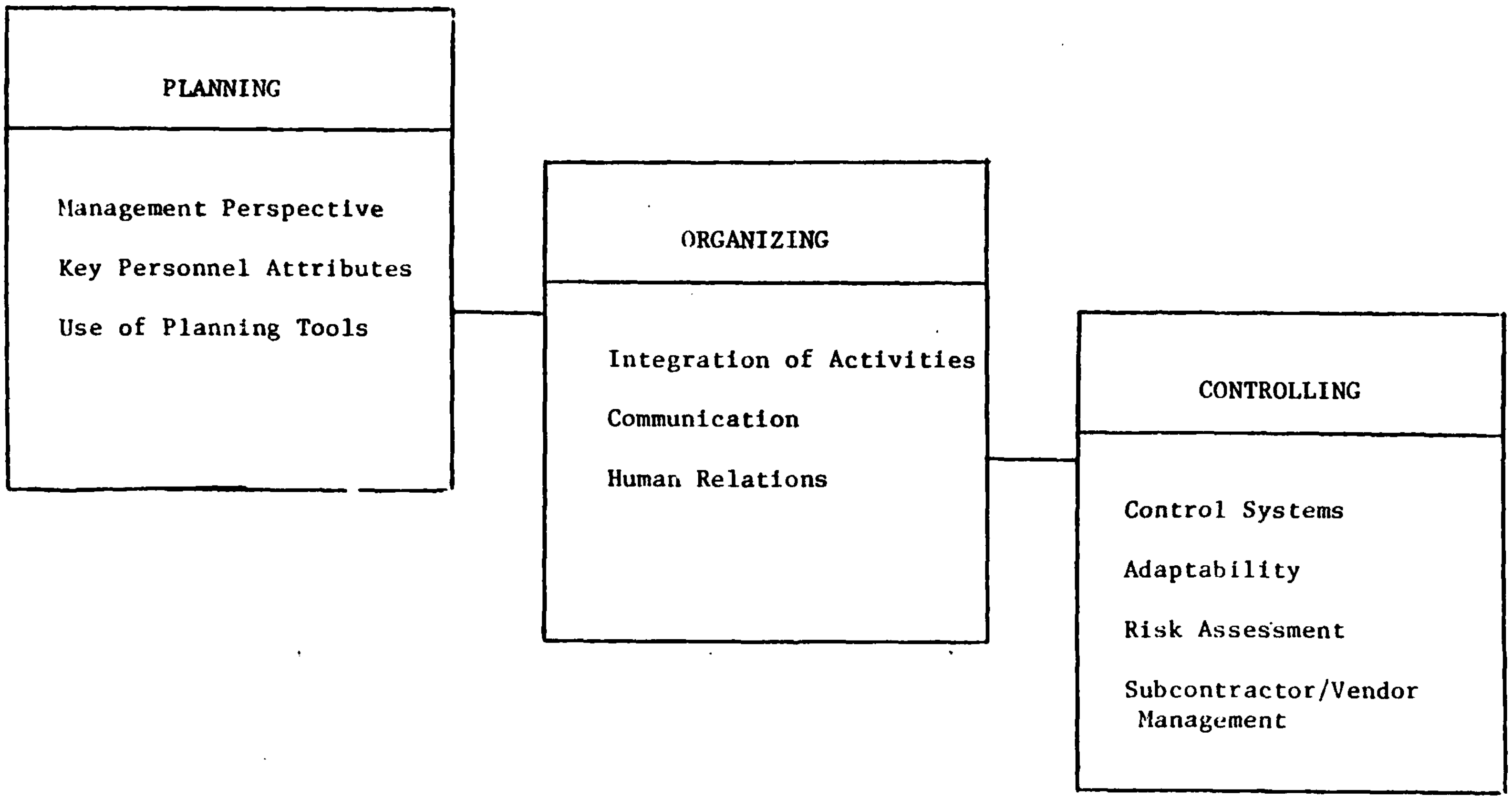
II. Approach

There are no data relating the success of contractor performance to management techniques. There are intuitive reasons to expect that management practices are directly responsible for contract success or failure. However, predicting such outcomes is nearly impossible given the number of variables involved. For example, organization design probably cannot be successfully related to specific performance without considering the technical environment (Lawrence and Lorsch, Organization and Environment: Managing Differentiation and Integration, Homewood, Illinois: Irwin, 1967). Empirical research has found that popular management tools such as PERT have been somewhat unrelated to success (Marquis, Don, "A Project Team + PERT = Success. Or Does It?" Innovation, Vol. 1, No. 3, July 1969).

Yet, this should not discourage nor prohibit the evaluation of contractor management in the source selection process. We find opposing views on the topic; for example, the Council of Defense and Space Industry Associations in 1974 state in a letter to OASD (I&L) that many items of information such as corporate organization are really incidental to the source selection process. Concomitantly, DOD Directive 4105.62 (Selection of Contractor Sources for Major Defense Systems) stresses the need to evaluate a firm's cost-conscious management. We suggest that avoiding the evaluation of a contractor's management capabilities is a very serious risk--particularly in a large, integrated systems procurement.

FIGURE 1

CONTRACTOR MANAGEMENT EVALUATION MODEL



Unfortunately, the literature is vague about models that evaluate management success. There are broad definitions such as OMB Circular A-40, where "management systems" include plans, requirements and controls for use in contractor management. Another source (Aeronautical Systems Division Pamphlet 800-6) suggests that the factors to be considered in evaluating management are: management approach, prior experience, projected work load throughout the period of performance, development schedule and demonstration milestones, engineering capability, manufacturing capability, quality assurance approach, program, (cost and reporting) control, continuing risk assessment and Cost/Schedule Control System Criteria (CSCSC) validation status. In essence, many variables are proposed; yet, a comprehensive, tested and proven model does not exist.

Our approach was to first examine the methods used by DOD contractors in evaluating alternative subcontractors. Visits to six major Air Force contractors provided us with interesting data. Industry evaluates the management of competing subcontractors in quite different ways. We were, however, able to sift through the various methods, identify similarities, and isolate specific variables, which, in conjunction with the management literature, provide the basis of the model.

We classified the variables into three major functional areas of management: planning, organizing, and controlling. A model depicting the result of our efforts appears in Figure 1. We then sent a draft concept paper to a number of government procurement experts, DOD contractors, and industry association groups for review and comment.

We received over 50 comprehensive critiques. This paper incorporates many of the ideas from these groups; but, of course, we alone accept the responsibility of the model, its development, and suggestions for its use.

III. Conceptual Model

The model is expanded by taking the form of a number of factors against which an evaluator answers a number of questions or responds to a series of statements. By using expert evaluators who, through their experience, have identified standards in each of the areas, a judgment can be made in terms of numerical scoring, subjective rankings, or descriptive adjectives.

Thus, the model can serve three functions. First, it can provide evaluations against a subjective or perhaps implicit set of standards. Second, it can provide comparisons between proposals, or third, it can serve to "red flag" major deficiencies of contractors under consideration. This latter area might well prove to be the most significant use of such a model. We again stress that each of the factors considered must be tailored to fit the individual procurement.

The format for each of the planning, organizing, and controlling sections of the management criteria are found in Appendices A through C. There are several factors and subfactors where an evaluator notes his evaluation in the space provided as he reviews the proposal and visits each contractor's facilities during the fact-finding stages of proposal evaluation.

A visit to the contractor is essential to discern the true state of management awareness as opposed to what appears in the written proposal. Unless this is done like the management fact-finding of past "Should Cost" exercises, this model will trigger off exercises in "brochuresmanship" and gaming that will negate any positive good of management assessment.

Further, a visit to the AFPRO, NAVPRO, or DCAS is essential to illuminate management capabilities from the customer's point of view. The plant representative should be a part of this evaluation team, for he would have firsthand information on the contractor's management systems and past performance. A fact-finding visit to each competing contractor is, then, an essential part of this evaluation system so that the buyer can be assured of the most factual management evaluation possible.

Within the model, the first area of evaluation is planning (Appendix A). Concerns here are the contractor's management perspective, qualifications of key management personnel, and the planning tools proposed in the contract. The contractor's philosophy concerns his long-range goals and objectives and how this contract will be integrated with those goals. Qualifications of key personnel are more tangible and require an assurance that the personnel identified in the proposal are actually going to be part of the contractor's team. The résumés of key program personnel are normally included in the management proposal and must be evaluated on their past experience and education. Planning tools include the use of budgets and schedules that assist management in meeting contract requirements. Caution must be exercised here to differentiate showy charts and graphs from clear, concise tools that will actually be used.

Organizing is the second area of evaluation. We do not suggest a critical evaluation with respect to the form of a contractor's organization. However, there are activities that are affected by the extent to which a contractor's organization is effective and efficient. The integration of functional elements is one such activity; *i.e.*, is there evidence that the contractor has good linkage between those elements working on the contract; has the structure proven effective in the past? At the same time, communication networks and media greatly influence the outcome of a project, and serve as a means of coordination. Finally, the human relations concerns of a contractor demonstrate the extent to which employees will be linked to the project itself. Appendix B defines these organizing factors and identifies how they would be evaluated.

One area of consideration not often considered is that of labor relations. We would agree that this area is not normally of prime importance, since it could be argued convincingly that we should not be concerned with the internal affairs of contractors or subcontractors. However, many of these internal affairs do end up having considerable impact on defense programs and, hence, we have included this in our model.

Controlling is the final factor as outlined in Appendix C. Here we are concerned with contractor feedback, adaptability, and capabilities for risk assessment. Related closely to communication, feedback is the contractor's assurance that he can control the critical elements of the program and meet program objectives. Adaptability is a measure of the contractor's ability to react to change. Risk assessment helps to define the contractor's evaluation and control over the cost, schedule, and technical uncertainties involved in the program. Finally, since a large portion of any contract is normally subcontracted, we must assure of contractor control over the sub's activities.

Any weight given to a contractor's management must be determined in advance of the issuance of the Request for Proposal (RFP). The source selection organization must carefully deliberate on the relative importance of each of the following areas:

1. technical
2. cost/price
3. management
4. quality
5. reliability
6. related experience
7. facilities
8. contract terms and conditions
9. other peculiar factors (test capability, performance requirements, etc.)

Our model does not suggest the relative worth of these factors for any given procurement. This must be carefully decided upon in advance of each RFP and is dependent also upon the objectives of the buying organization.

IV. Use of the Model

We see the model being used in the source selection process in one of three ways. First, each of the factors may be numerically scored, and the best proposal evaluated in terms of the organization receiving the highest score on all factors. We recognize that a point scoring system presumes a level of measurement that may be difficult to achieve. Despite this, numerical scoring can be a useful tool. A second possibility might be to make successful comparisons and color code each of the variables in relation to the degree to which each variable is satisfied by the competing contractors or subcontractors. Or third, descriptive adjectives might be used, again to compare the relative degree to which each contractor has satisfied the variables selected.

A numerical scoring procedure provides a most precise result, but is backed up by a great number of questionable assumptions. Because it is so difficult to quantify subjective judgments, many reviewers of the draft concept paper categorically rejected our initial model because of our use of a point scoring system. Quantification of subjective probabilities is becoming a widely accepted technique in making business decisions, but we believe it has few advocates in government contracting because of the ease with which subjective judgments can be challenged in the courts. Nonetheless, there are examples of contract evaluations using the point scoring system (e.g., Greek base maintenance contracts) where source selection panels were confident of evaluating the contractors' proposals.

Appendix D includes an entire proposal evaluation example with a point scoring system that integrates the management evaluation with technical capability, cost, and six other factors. The reader must understand that the assigned points possible are an example and would be decided prior to an RFP, thus being unique in each individual procurement. However, each evaluator would assign the points and arrive at a total score to rank alternative contractors' proposals. A question arises with respect to firms receiving a zero score, but it could be solved easily by briefing the contractor on his deficiency and allowing him to correct the problem, thereby improving the score, or by placing a greater emphasis on any category where a zero score occurred. This appendix demonstrates a completed selection model for a hypothetical satellite program. The evaluation criteria would be placed in the RFP in their relative order of importance. However, ASPR 3-501 (B) sec d (i) prohibits the disclosure of weights in the solicitation. The scoring should never be the absolute evaluative tool. An example of where this scoring procedure has been successfully used is the procurement of contract services at the FY 75/78 Greece Base Maintenance contract. Each of the scored items received points on the basis of the evaluation team's analysis and assumption that possible points awarded reflected contractor capabilities for each of the variables evaluated.

Color coding can be used not only to "red flag" contractor deficiencies, but also to compare the relative capabilities of contractors' proposals. Appendix E gives an example for contractor management proposals showing how a color coding procedure might be used. Such a procedure is in use by the Air Force Contract Management Division in its management system indicators. Green indicates satisfactory, yellow that corrective action would be necessary, red unsatisfactory, and black items not yet evaluated. Thus, alternative proposals could be compared on the basis of the numbers of each color for the variables under consideration.

Finally, descriptive adjectives can be used for each of the variables under consideration. As in Appendix E, the management variables could be read as highly unsatisfactory, unsatisfactory, neither satisfactory nor unsatisfactory, satisfactory, or highly satisfactory. Comparisons between competing firms could then be made on the ratings of each of the items, but without applying specific scores or weights.

The experience of the personnel selected to be on the management evaluation is critical for the successful review of the contractor's management. During the source selection process, it is all too often difficult to free a program office's most experienced and knowledgeable people for they are charged with the management of the entire source selection process. It is essential to utilize the most qualified people available for this critical evaluation just as is now being done on technical evaluations. It can be argued by some that the contractor's management ability is reflected in the quality of his technical report, particularly in the areas of the program master schedule task interrelationship, and risk assessment. If the company management is on top of the specific key technical issues, it should show in the technical proposal. We, therefore, recommend that the management evaluation team formally meet with the various technical teams to exchange ideas on the management of the technical effort.

Another area where technical personnel can be of prime help is in reviewing the skills of the key technical personnel proposed. Evaluation of proposed personnel based upon résumés is sometimes inadequate, and a better evaluation of an individual's worth and experience might be better made by face-to-face in-depth discussions by experienced and skilled interviewers. Experienced technical people can provide this skill and experience to the management evaluation team.

One final emphasis is the need for an extensive plant visit to meet with the contractor's proposed management people and view firsthand the proposed facilities. Coordination with the AFPRO or DCAS people is essential if detailed information is to be gathered and integrated with this model. This model requires good, experienced evaluators for its successful implementation.

V. Summary

The model, while not intended to be exhaustive, provides as complete a set of criteria as possible in application to wide varieties of contract situations. The evaluation criteria must be adapted to the individual procurement. Some of the items in the appendices may be redundant; most, however, can be reworded to fit nearly any type of hardware or service proposal. It is up to the source selection organization to decide upon the factors to be evaluated. Much of this work must be done before the RFP is written so that the data needed for analysis will be included in every contractor's proposal.

The following is suggested as the wording for each RFP that will solicit the proper management information from each contractor:

"Describe your organization, related experience, and the management methods you will use to manage this program. Your proposal should include the following information:

a. Company and project organization charts.

b. Name of project manager and key personnel with a brief résumé of each.

c. Authority or charter of project manager.

d. Schedules showing significant program activity times and milestones.

e. Related experience on similar hardware--list related hardware built or launched in last five years with summary of technical performance. Provide photographs of most recent related hardware.

f. Description of project control and risk assessment systems.

g. Total number of personnel and number of engineers employed in facility, plus program manpower loading.

h. Description of facilities including manufacturing and engineering areas, test equipment and environment facilities."

We have provided a structure for evaluating contractor management during source selection. How this structure is used is not a goal of this paper; rather, we want to emphasize that contractor management can and should be evaluated during source selection. A concept has been developed, but it is the process that can be individualized to meet specific needs.

BIBLIOGRAPHY

1. Aerospace Industries Association, "United States Air Force Requests for Proposals--Critique and Recommendations," May 1971.

2. Department of the Air Force, Air Force Manual 70-6, "Procurement: Source Selection Policy," Headquarters, U.S. Air Force, 22 June 1973.

3. Department of the Air Force, Air Force Regulation 70-15, "Procurement: Source Selection Policy," Headquarters, U.S. Air Force, 22 June 1974.

4. Department of the Air Force, Air Force Systems Command, "Project Ace Findings and Progress Report," Andrews AFB, Maryland, June 1974.

5. Fox, J. Ronald, *Arming America: How the U.S. Buys Weapons*, Cambridge, Mass.: Harvard University Press, 1974.

6. Lawrence, Paul R., and Lorsch, Jay W., Organization and Environment: Managing Differentiation and Integration, Homewood, Illinois: Irwin, 1967.

7. Logistics Management Institute, "Contractor Performance Evaluation in Source Selection," LMI Task 69-2, Washington, D.C., October 1968.

8. Logistics Management Institute, "Introduction to Military Program Management," LMI Task 69-28, Washington, D.C., March 1971.

9. Marquis, Don, "A Project Team + PERT = Success. Or Does It?" Innovation, Vol. 1, No. 3, July 1969.

10. Morris, Steele, "'Communications Effectiveness' Needed in RFP-Proposal-Contract Award Cycle," Defense Management Journal, January 1973.

11. Stewart, Lt Gen James T., USAF, "Source Selection Process Faces Winds of Change," Defense Management Journal, January 1973.

Appendix A

CRITERIA FOR EVALUATION OF PLANNING

EVALUATION

1. Management Perspective

   a. Establishes suitable sensors as an accurate measure of planned accomplishments. ____________________

   b. Understands government requirements:

      1. Approved Procurement Manual ____________________

      2. Approved Accounting System by Government Agency

      3. Approved Material Control Manual ____________________

      4. Approved Property Accountability Manual ____________________

   c. Use of Management by Objectives, Participative Management, or other well-defined concept of management planning to set goals. ____________________

2. Qualifications of Key Management Personnel

   a. Does the proposal identify assignment of key personnel by name? ____________________

      1. Are they available from the present complement? ____________________

      2. Are these people now working on this program? ____________________

      3. Do these people have adequate authority? ____________________

Appendix A
(continued)

EVALUATION

b. Is the contractor's first and second level management qualified in relation to the job?

1. Average experience level in management programs: ____________

2. Average tenure with company: ____________

3. Total management experience: ____________

4. Achievements--For what have key management personnel earned recognition? ____________

5. Average education level of management personnel: ____________

6. Progression: ____________

7. Cohesiveness--Is there evidence of management working as a team? ____________

c. Does the contractor have the specialized personnel that he requires for this job (i.e., tool designers, test engineers, technicians, etc.)?* ____________

1. Average level of technical/special experience: ____________

2. Average level of education of technical/special personnel: ____________

3. Are these people available within the company? ____________

3. Use of Planning Tools

a. Schedules. Is schedule detailed by phase plan for the entire project in accordance with program requirements? ____________

*The true evaluation of the worth of these individuals can only come by a face-to-face in-depth discussion by a skilled interviewer.

Appendix A
(continued)

EVALUATION

1. Details--sub-factors ______________________

2. Implementation of plan ______________________

3. Periodic check points ______________________

4. Flow charts ______________________

b. Costs. Are costs budgeted in accordance with program requirements? ______________________

c. Does the contractor have adequate manpower loading charts? ______________________

d. Does the contractor have this manpower hired now? ______________________

Appendix B

CRITERIA FOR EVALUATION OF ORGANIZING

	EVALUATION
1. Integration of Activities	
a. Research and Development Coordination	____________
b. Design Capabilities:	
1. Does the contractor drawing system <u>comply</u> so that approval of drawings will be rapid?	____________
2. Engineering progress control	____________
c. Technical Writing	____________
d. Reliability	____________
e. Test Functions	____________
f. Tooling	____________
2. Communication	
a. How quickly and concisely is information disseminated by the contractor?	____________
b. What kind of system exists for Significant Incident Reporting?	____________
c. Customer coordination	____________
d. Subcontractor information	____________
e. Timely advice and notification of decisions	____________
3. Human Relations	
a. Does the contractor have an on-going program of human relations for his employees?	____________

Appendix B
(continued)

EVALUATION

b. Labor Relations:

1. Acceptance of Policy Manual to Air Force ________________

2. Union relationship ________________

3. Fringe benefits ________________

4. Turnover experiences ________________

5. Work stoppage potential ________________

Appendix C

CRITERIA FOR EVALUATION OF CONTROLLING

EVALUATION

1. Control Systems. What controls does the contractor propose for the following items:

   a. Direct costs __________

   b. Indirect costs. Does the contractor have adequate visibility and control of indirect costs? __________

   c. Direct manpower __________

   d. Indirect manpower __________

   e. Program progress __________

   f. Reports __________

   g. Changes __________

   h. Does the contractor have a validated CSCSC or an acceptable cost and schedule control system? __________

   i. Does the contractor's management Information System provide management with the proper information for program decisions? __________

2. Adaptability

   a. Does the contractor have a system for processing change orders? __________

   b. Is there management flexibility to revise programming to make up for schedule slippage? __________

   c. Is the contractor presently overloaded? __________

Appendix C
(continued)

EVALUATION

3. Risk Assessment

   a. Does the contractor propose a system for assessment of technical uncertainty? __________

   b. Has the proposed system been used successfully on previous programs? __________

   c. Are the technical parameters chosen for evaluation and tracking adequate? __________

   d. Has schedule risk been evaluated? __________

4. Subcontract Management

   a. Has the contractor identified proposed subcontractors? __________

   b. Has he fully justified his "make-or-buy" decisions and subcontractor qualifications? __________

   c. Are the lines of responsibility for subcontract management clear? __________

   d. Are the numbers and quality of personnel assigned to subcontractor management adequate? __________

   e. Does the subcontractor management system demonstrate reasonable control over costs, schedules, and technical aspects of subcontractors? __________

   f. Are the sub's cost, schedule and technical performance integrated into contractor's overall system? __________

   g. Does subcontractor have a validated CSCSC or acceptable system? __________

Appendix D

EXAMPLE OF COMPLETE EVALUATION MODEL USING POINT SCORING

This appendix is a complete example of an evaluation system using point scoring. The factors are for example only, and the point allocations show an example of the relative importance of each factor. The points assigned to each factor must be carefully assigned in advance of the request for proposal, and specifically tailored for each individual procurement by the source selection authority.

RELATIVE WEIGHTS OF FACTORS

	Factor	Points
1.	Technical	550
2.	Cost	400
3.	Management	250
4.	Quality	100
5.	Reliability	40
6.	Experience	80
7.	Facilities	50
8.	Contract	30
	TOTAL POINTS	1500

Appendix D
(continued)

SCORE SUMMARY SHEET - Page 1

CONTRACTOR ______________________________

	RATED VALUE	RATING*
EVALUATION FACTORS		
1. Technical (From Section 1)		
a. Design Characteristics	150	____
b. Materials and Processes	150	____
c. Capability	150	____
d. Growth Potential	50	____
e. Responsiveness to Statement of Work	50	____
TOTAL	550	☐

2. Cost (From Section 2)

The following represents the contractor's relative price rankings and is contrasted to the buyers "in house" estimate:

NOTE: This evaluation is supported by the pricing memorandum.

Additionally, the following factors have been considered as applicable:

	Comments
a. Financial Capability	
b. Accounting System	
c. Overrun/Underrun History	
d. Estimating System	
e. Cost Control Management	
f. Recurring vs. Non-recurring Elements	
g. Adequacy of Cost Data--Have all elements of cost been identified?	

*Rating obtained from the detailed evaluation worksheets found in Sections One through Eight which follows this summary.

Appendix D
(continued)

SCORE SUMMARY SHEET - Page 2

Comments

h. Cost Risk Assessment

i. Other

	RATED VALUE	RATING
3. Management (From Section 3)		
a. Planning	100	____
b. Organizing	40	____
c. Controlling	110	____
TOTAL	250	☐
4. Quality Assurance (From Section 4)		
a. Organization and Management	20	____
b. Quality Systems and Implementation	20	____
c. Equipment and Facilities	60	____
TOTAL	100	☐
5. Reliability (From Section 5)		
a. Reliability Program Plan	30	____
b. Technical Assurance	10	____
TOTAL	40	☐
6. Experience (From Section 6)		
a. Experience - Prior experience on similar projects	40	____
b. Experience - Performance	40	____
TOTAL	80	☐

Appendix D
(continued)

SCORE SUMMARY SHEET - Page 3

		RATED VALUE	RATING
7.	Facilities (From Section 7)		
	a. Manufacturing & Support Capabilities	35	____
	b. Available Floor Space	5	____
	c. Plant Layout	10	____
	TOTAL	50	
8.	Contract (From Section 8)		
	a. Acceptance of Air Force Terms and Conditions	10	____
	b. Subcontracts Requirements & Criteria	15	____
	c. Make or Buy	5	____
	TOTAL	30	
	CONTRACTOR TOTAL	1500	

SECTION 1

TECHNICAL EVALUATION WORKSHEET

NOTE: EVALUATION FACTORS FOR EXAMPLE ONLY

CONTRACTOR ____________________

DATE ____________________

EVALUATOR ____________________

	TOTAL POSSIBLE POINTS	POINTS
A. Design Characteristics		
1. Diameter and F/D	10	______
2. Weight	10	______
3. Center of Gravity	5	______
4. Unit Envelope and Mounting Provisions	5	______
5. Thermal Control	40	______
o Distortions		
o Interface		
6. Adjustment Capability	30	______
o Reflector		
o Subreflector		
7. Testing and Inspectability	20	______
8. RF Compatibility	20	______
9. Design Compatibility	10	______
Total	150	______

NOTE: EVALUATION FACTORS FOR EXAMPLE ONLY

	TOTAL POSSIBLE POINTS	POINTS
B. Materials and Processes		
1. Material Selection Criteria	25	______
2. Fabrication Processes	75	______
3. Test Methods and Equipment	50	______
Total	150	______
C. Capability		
1. Demonstrated understanding of key problem areas, technical risks and uncertainties, technical competence, and past experience	50	______
2. Current development status of applicable technology areas	20	______
3. Demonstrated analytical capability for determination of thermal distortion and design margins	30	______
4. Verification Test Program Plans	20	______
5. Demonstrated verification of design and performance claims relating to:		
o Environmental Tests	10	______
o Solar Simulation T/V Tests	5	______
o Ambient Pressure Distortion	5	______
o RF Efficiency Tests	10	______
Total	150	______

NOTE: EVALUATION FACTORS FOR EXAMPLE ONLY

	TOTAL POSSIBLE POINTS	POINTS
D. Growth Potential		
1. Increased Diameter	20	____
2. Utilization of Lens/Feed	10	____
3. Capability for Shaping of Reflector and Subreflector	20	____
Total	50	____
E. Responsiveness to Statement of Work		
1. Technical Approach	25	____
2. Program Planning	25	____
Total	50	____
TOTAL POSSIBLE	550	
TOTAL RECEIVED		

NOTE: EVALUATION FACTORS FOR EXAMPLE ONLY

SECTION 2
COST/PRICE EVALUATION

Because of the experience and expertise available and in use on all procurements, no guidance is necessary in this area. Cost/Price proposals must be evaluated relative to each other, and against buyers' independent cost estimate. Life cycle costs must be considered.

SECTION 3
MANAGEMENT EVALUATION

CONTRACTOR ______________________________

DATE ______________________________

EVALUATOR ______________________________

	POINTS POSSIBLE	POINTS AWARDED
PLANNING		
1. Management Perspective		
a. Establishes suitable sensors as an accurate measure of planned accomplishments.	6	____
b. Understands Government Requirements:		
1. Approved Procurement Manual	4	____
2. Approved Accounting System by Government Agency	6	____
3. Approved Material Control Manual	2	____
4. Approved Property Accountability Manual	2	____
c. Use of Management by Objectives, Participative Management, or other well-defined concept of management planning to set goals	4	____
2. Qualifications of Key Management Personnel		
a. Does the proposal identify assignment of key personnel by name?	2	____
1. Are they available from the present complement?	2	____
2. Are these people now working on this program?	4	____
3. Do these people have adequate authority?	2	____

	POINTS POSSIBLE	POINTS AWARDED
b. Is the contractor's first and second level management qualified in relation to the job?		
1. Average experience level in management programs:	6	
2. Average tenure with company:	2	
3. Total management experience:	6	
4. Achievements--For what have the key management personnel earned recognition?	6	
5. Average education level of management personnel:	2	
6. Progression:	2	
7. Cohesiveness--Is there evidence of management working as a team?	6	
c. Does the contractor have the specialized personnel that he requires for this job (*i.e.*, tool designers, test engineers, technicians, etc.)?	6	
1. Average level of technical/special experience:	2	
2. Average level of education of technical/special personnel:	2	
3. Are these people available within the company?	2	
3. Use of Planning Tools		
a. Schedules. Is schedule detailed by phase plan for the entire project in accordance with program requirements?	4	
1. Details--sub-factors	2	
2. Implementation of plan	2	
3. Periodic check points	2	
4. Flow charts	2	

	POINTS POSSIBLE	POINTS AWARDED
b. Costs. Are the costs budgeted in accordance with program requirements?	4	
c. Does the contractor have adequate manpower loading charts?	6	
d. Does the contractor have this manpower hired now?	2	
PLANNING TOTAL	100	

ORGANIZING

1. Integration of Activities

a. Research and Development Coordination	4	
b. Design Capabilities:		
1. Does the contractor drawing system comply to buyers' requirements and formats so that approval of drawings will be rapid?	2	
2. Engineering progress control	2	
c. Technical Writing	2	
d. Reliability	2	
e. Test Functions	2	
f. Tooling	2	

2. Communication

a. How quickly and concisely is information disseminated by the contractor?	2	
b. What kind of system exists for Significant Incident Reporting?	2	
c. Customer coordination	2	

	POINTS POSSIBLE	POINTS AWARDED
d. Subcontractor information	2	
e. Timely advice and notification of decisions	2	
3. Human Relations		
a. Does the contractor have an ongoing program of human relations for his employees?	4	
b. Labor Relations:		
1. Acceptance of Policy Manual to Air Force	2	
2. Union relationship	2	
3. Fringe benefits	2	
4. Turnover experiences	2	
5. Work stoppage potential	2	
ORGANIZING TOTAL	40	
CONTROL		
1. Control Systems--What controls does the contractor propose for the following items:		
a. Direct costs	6	
b. Indirect costs: does the contractor have adequate visibility and control of indirect costs?	6	
c. Direct manpower	2	
d. Indirect manpower	2	
e. Program progress	2	
f. Reports	2	

	POINTS POSSIBLE	POINTS AWARDED
g. Changes	2	
h. Does the contractor have a validated CSCSC or an acceptable cost and schedule control system?	8	
i. Does the contractor's management information system provide management with the proper information for program decisions?	5	
2. Adaptability		
a. Does the contractor have a system for processing change orders?	5	
b. Is there management flexibility to revise programming to make up for schedule slippage?	5	
c. Is the contractor presently overloaded?	5	
3. Risk Assessment		
a. Does the contractor propose a system for assessment of technical uncertainty?	10	
b. Has the proposed system been used successfully on previous programs?	5	
c. Are the technical parameters chosen for evaluation and tracking adequate?	5	
4. Subcontract Management		
a. Has the contractor identified proposed subcontractors?	10	
b. Has he fully justified his "make-or-buy" decisions and subcontractor qualifications?	5	
c. Are the lines of responsibility for subcontract management clear?	5	

		POINTS POSSIBLE	POINTS AWARDED
d.	Are the numbers and quality of personnel assigned to subcontractor management adequate?	5	
e.	Does the subcontractor management system demonstrate reasonable control over costs, schedules, and technical aspects of subcontractors?	5	
f.	Are the sub's cost, schedule and technical performance integrated into contractor's overall system?	5	
g.	Does subcontractor have a validated CSCSC or acceptable system?	5	
	CONTROL TOTAL	110	

MANAGEMENT EVALUATION TOTAL*	Total Possible	250	
	Total Received		

*Sum of totals for Planning, Organizing, and Controlling

SECTION 4

QUALITY ASSURANCE EVALUATION

CONTRACTOR ______________________________

DATE ______________________________

EVALUATOR ______________________________

		TOTAL POSSIBLE POINTS	POINTS
A.	Organization and Management	20	______
B.	Quality Systems and Implementation	20	______
C.	Equipment and Facilities	60	______
	Total Possible	100	
	Total Received		

D. Comments:

SECTION 5
RELIABILITY EVALUATION

CONTRACTOR ______________________________

DATE ______________________________

EVALUATOR ______________________________

	TOTAL POSSIBLE POINTS	POINTS
A. Reliability Program Plan	30	______
Does proposal demonstrate intent to be responsive to reliability program requirements?		
B. Technical Assurance of a Reliable Design	10	______
Does proposal demonstrate group of technical factors contributing to product reliability?		
Total Possible	40	
Total Received		$\boxed{}$

C. Comments:

SECTION 6
EXPERIENCE EVALUATION

CONTRACTOR ______________________

DATE ______________________

EVALUATOR ______________________

	TOTAL POSSIBLE POINTS	POINTS
A. Prior Experience on Similar Projects		
1. Comparative experience (consider the following):		
a. What companies or Government contracts	8	____
b. Magnitude and Scope	8	____
c. Prime or Sub	8	____
d. Dollar Value	8	____
e. Type or effort (contract)	8	____
Total Possible	40	
Total Received		☐
B. Performance (this data can be obtained from the AFPRO, DCAS, NASA, etc.)		
1. History		
a. Evidence of prior performance on like or similar programs	5	____
b. Commendations (Accomplishments)	5	____
c. Evidence of satisfactory completion of tasks assigned		
(1) Quality	5	____
(2) Schedule	5	____
d. Progression of State of the Art and accomplishment	4	____

	TOTAL POSSIBLE POINTS	POINTS
e. Cost history (overruns or underruns)	10	
f. Problem solving capability	2	
g. Contract Administration	2	
h. Public relations	2	
Total Possible	40	
Total Received		

C. Comments:

SECTION 7
FACILITIES EVALUATION

CONTRACTOR ____________________

DATE ____________________

EVALUATOR ____________________

	TOTAL POSSIBLE POINTS	POINTS
A. Manufacturing and Support Capabilities, Tools, Equipment and Special Devices		
1. Does the contractor have adequate production machines or is it just a prototype shop?	20	
2. Does the contractor have adequate support capabilities for his R&D and production? (i.e., reproduction, calibration, X-ray, etc.)	15	
B. Available Floor Space	5	
C. Plant Layout (Consider these factors and others)		
1. Relation of Engineering to production facility	5	
2. Relation of Receiving to Plant Operations	2	
3. Relation of Production Control to Production Plant	2	
4. Proximity and accessibility to commercial transportation	1	
Total Possible	50	
Total Received		

SECTION 8
CONTRACT EVALUATION

CONTRACTOR ____________________

DATE ____________________

EVALUATOR ____________________

	TOTAL POSSIBLE POINTS	POINTS
A. Acceptance of buyer terms and conditions		
1. Has contractor taken exception to special clauses, alterations of contract requirements?	yes/no	
2. Are exceptions of such magnitude as to preclude negotiations? List exceptions:	5	____

EXCEPTIONS | DISPOSITION

	TOTAL POSSIBLE POINTS	POINTS
3. Did contractor propose his own terms and conditions or special provisions so as to preclude negotiations?	5	____
Total Possible	10	
Sub-Total Received		____
B. Contracts Requirements and Criteria		
1. Is percentage of subcontract proposed by supplier excessive?	1	____

	TOTAL POSSIBLE POINTS	POINTS
2. How will supplier control sub-contractors in the following areas:		
a. Expediting	3	
b. Planning	3	
c. Status	3	
3. Does the contractor have an adequate "make-or-buy" function within his organization?	10	
Total Possible	20	
Sub-Total Received		
TOTAL RECEIVED		

NOTE: Exceptions taken to the contract or other contract terms and conditions should be subject to negotiation and not the basis for having the proposed declared non-responsive or downgraded.

APPENDIX E

EXAMPLE OF COLOR CODING EVALUATION SYSTEM
(Sample Page)

	COLOR CODE
h. Does the contractor have a validated CSCSC or an acceptable cost and schedule control system?	Green
i. Does the contractor's management information system provide management with the proper information for program decisions?	Green
2. Adaptability	
a. Does the contractor have a system for processing change orders?	Yellow
b. Is there management flexibility to revise programming to make up for schedule slippage?	Green
c. Is the contractor presently overloaded?	Black
3. Risk Assessment	
a. Does the contractor propose a system for assessment of technical uncertainty?	Green
b. Has the proposed system been used successfully on previous programs?	Green
c. Are the technical parameters chosen for evaluation and tracking adequate?	Yellow
4. Subcontract Management	
a. Has the contractor identified proposed subcontractors?	Green
b. Has he fully justified his "make-or-buy" decisions and subcontractor qualifications?	Green
c. Are the lines of responsibility for subcontract management clear?	Green

APPENDIX F

EXAMPLE OF DESCRIPTIVE ADJECTIVE EVALUATION SYSTEM
(Sample Page)

	EVALUATION
h. Does the contractor have a validated CSCSC or an acceptable cost and schedule control system?	Highly Satisfactory
i. Does the contractor's management information system provide management with the proper information for program decisions?	Highly Satisfactory
2. Adaptability	
a. Does the contractor have a system for processing change orders?	Unsatisfactory
b. Is there management flexibility to revise programming to make up for schedule slippage?	Highly Satisfactory
c. Is the contractor presently overloaded?	Neither Satisfactory nor Unsatisfactory
3. Risk Assessment	
a. Does the contractor propose a system for assessment of technical uncertainty?	Highly Satisfactory
b. Has the proposed system been used successfully on previous programs?	Highly Satisfactory
c. Are the technical parameters chosen for evaluation and tracking adequate?	Satisfactory
4. Subcontract Management	
a. Has the contractor identified proposed subcontractors?	Highly Satisfactory
b. Has he fully justified his "make-or-buy" decisions and subcontractor qualifications?	Highly Satisfactory
c. Are the lines of responsibility for subcontract management clear?	Highly Satisfactory

A NEW APPROACH TO PROCUREMENT ADMINISTRATIVE LEAD TIME (PALT) MANAGEMENT, A CONTINUING PROCUREMENT PROBLEM

by

Kimrey D. Newlin

Edward T. Lovett*

September 1976

*Both authors are currently employed in the US Army Procurement Research Office (APRO), Fort Lee, Virginia. This paper is based on the results of APRO research project 516 entitled, "Development of Procurement Administrative Lead Time (PALT) Management and Performance Criteria." The views set forth in this article are those of the authors and should not be construed to represent the official position of the US Department of the Army unless so stated.

ABSTRACT

This paper re-examines the traditional ideas about PALT as well as the current reality in order to develop realistic PALT management and performance criteria.

INTRODUCTION

The purpose of procurement is to furnish to the user what he requires, when he requires it, at a fair and reasonable price. Procurement Administrative Lead Time (PALT), which covers the pre-award procurement cycle, is a major part of total Procurement Lead Time (PLT). PALT is one of the primary determinates of when the user will get the material he needs. The real issue is how long it will take procurement to get a procurement directive (PWD) on contract. Higher headquarters has always been interested in reducing the time required to get material to the troops and has traditionally used PALT as a measure of efficiency. Additionally, PALT is an extremely important planning factor for inventory control, especially during a wartime situation, since any delay in the procurement cycle could potentially be detrimental to the war effort.

BACKGROUND ON PALT

Over the years there has been one continuous problem that has received much procurement emphasis; i.e., PALT (11). PALT has generally been viewed as being one of the primary causes of failure to meet the users' required delivery date (8). Consequently, previous research on PALT has concerned itself almost exclusively with how to reduce PALT rather than how to better manage PALT. Also, in recent years, procurement managers have complained that the constant emphasis on reducing PALT has limited their options considerably and that a new, more modern management approach is required for PALT. The Army Procurement Research Office (APRO) at Fort Lee, Virginia, recently undertook a study to re-examine traditional ideas about PALT as well as current reality in order to develop more appropriate PALT management and performance criteria.

NEED FOR SYSTEMATIC STUDY OF PALT

Existing PALT management practices must be re-evaluated in terms of their value, usefulness and cost. Procurement managers need a more appropriate set of PALT management criteria against which to measure the effectiveness of the mission for which they are responsible. Thus, by measuring accomplishments against PALT management criteria, procurement managers will be better able to plan, direct, manage, and control the pre-award procurement cycle.

STUDY OBJECTIVES

The objectives of the study were:

1. Analyze an Army command's current system for managing PALT and develop appropriate PALT management and performance criteria.

2. Determine meaningful PALT objectives as an aid in managing PALT.

3. Establish PALT management and performance criteria for use by procurement managers.

STUDY APPROACH AND RESEARCH METHODS EMPLOYED

Traditional research methods consisting of reviewing publications and ongoing research on PALT as well as interviewing key procurement management officials at an Army HQ Command and its Major Subordinate Commands (MSCs) were employed. Additionally, a more modern, scientific method was used in this study to design the data collection plan, collect the data and then apply quantitative techniques to the management of PALT.

CONSISTENT DEFINITION AND CONVENTION IS NECESSARY FOR GOOD PALT MANAGEMENT

Just as all orchestra members must be reading from the same sheet of music or it will sound like "hell", all procurement managers must use the same PALT criteria if PALT is to be managed properly. That is, every MSC must be measured on a common base so that their PALT's will be comparable to a target and standard. In order to do this, PALT must be clearly defined as well as the segments which make up procurement lead time (PLT).

PLT can best be defined with the use of a diagram illustrating the breakout of its component lead times. Figure 1 illustrates the components of PLT and will be used as a frame of reference in this article.

Procurement Lead Time (PLT) is defined as "the interval in months between the initiation of procurement action* and receipt into the supply

---

*Initiation of procurement action is "that point in time when the approved document requesting procurement and citing funds is forwarded to the procuring activity (1)."

system** of the production model (excludes prototypes) purchased as the result of such actions, and is composed of two elements, production lead time and administrative lead time (1)."

The first major component of PLT is administrative lead time (ALT) which is defined as "the time interval between initiation of procurement action and letting of contract or placing of order (1)." The second major segment of PLT is Production Lead Time (PDNLT) which is defined as "the time interval between the placement of a contract and receipt into the supply system of material purchased (1)."

Procurement Administrative Lead Time (PALT) is defined as "the measurement of calendar days connected with the receipt of a procurement directive (PWD) accepted by a procurement and production directorate as a package (funded or unfunded) adequate to initate procurement of a requirement, and continues until the execution (award) of a procurement instrument (9)." Figure 1 illustrates that PALT is a subset of ALT and is synonymous with the pre-award procurement cycle. Also, PALT is the principal component of PLT over which procurement has primary, but not complete control. PALT excludes the requirements cycle or the time the requiring activity needs to prepare the PWD.

**Receipt into the supply system is "that point in time when the first item or first quantity of the item of the contract has been received at or is en route to point of first delivery after inspection and acceptance (1)."

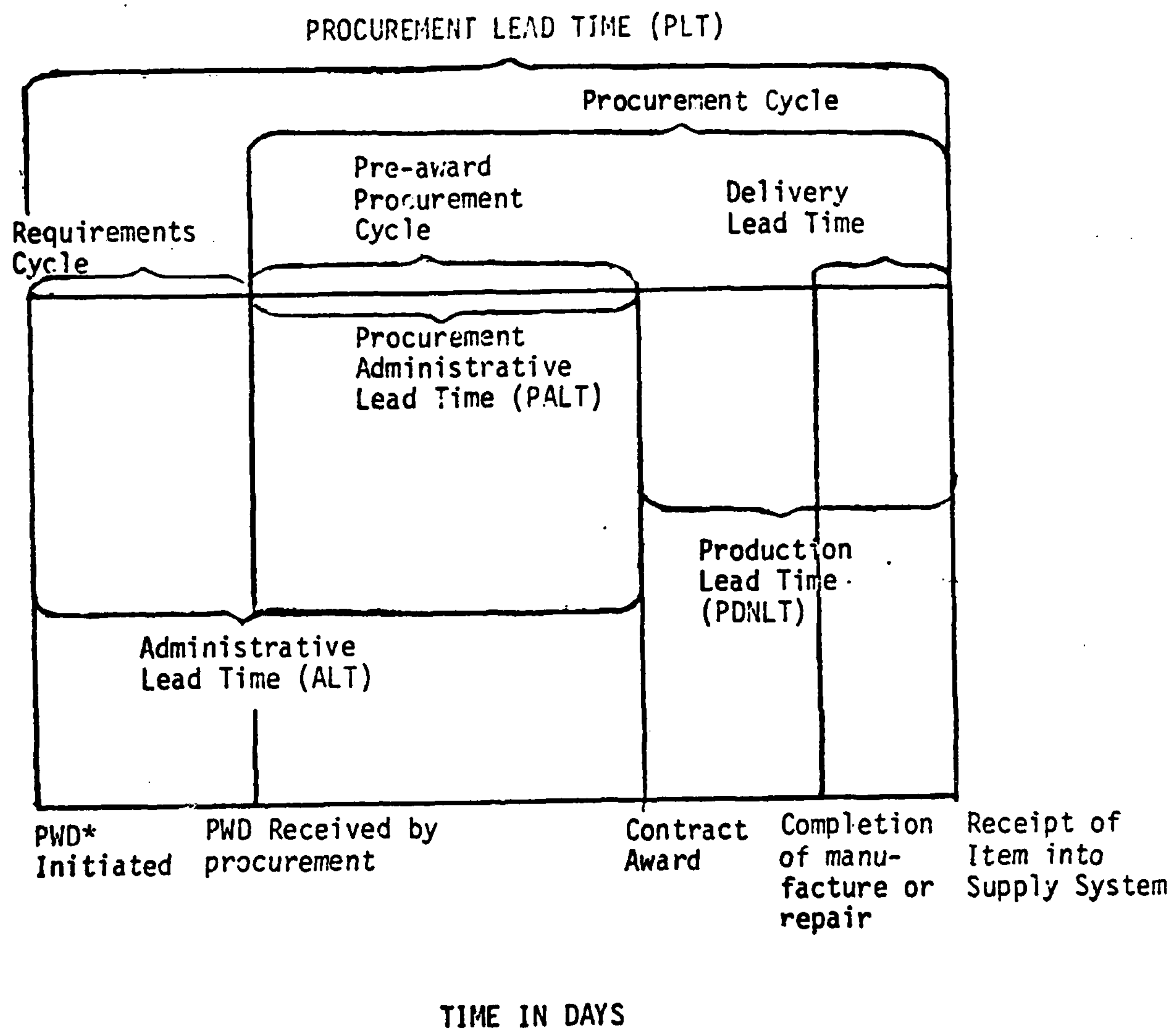


FIGURE 1. BREAKOUT OF THE COMPONENT LEAD TIMES WHICH MAKE UP PROCUREMENT LEAD TIME

* Legend: Procurement Directive (PWD) is the document which authorizes funds and/or authority for specific goods or services to be procured.

As shown on Figure 1, the last component, Delivery Lead Time (DLT) is a subset of PDNLT and is not as has often been misinterpreted in the past the same as PDNLT. DLT is defined as "the time interval between completion of manufacture or repair of an item and the receipt of the first scheduled shipment into the supply system (1)."

It was found that PALT is currently being reported differently by the individual MSCs. This is being caused by several factors - varying interpretations of the actual definition of PALT, when to start measuring PALT, and finally what time periods to include or exclude from PALT. This last factor is important due to the fact that there are certain provisions in the automated data collection system for non-accrual of PALT.

Thus, it was realized that the current PALT definition was not adequate to determine when to start measuring PALT in collecting PALT data. Specific questions that arose were: (1) When is a PWD accepted?, (2) Must funds be available?, and (3) Must adequate specifications and/or the technical data package be available? Based upon the analysis and consultation with PALT coordinators, it was decided that the following PALT definition would be used: The number of calendar days beginning with receipt in the procurement office of an approved document, citing funds and complete with all data necessary to solicit and award a contract and ending on the award date. This definition would approximate the definition of PALT as measured under the agency's automated system (which contains provisions for non-accrual of PALT if certain events occur).

PALT MANAGEMENT

It was observed that although few of the MSCs have written policy on PALT, most of the MSCs are concerned about PALT and are attempting to improve their management of PALT.

Most of the MSC's believe PALT to be an appropriate management objective. However, they feel that a more appropriate set of PALT management standards is needed together with emphasis on PALT from HQ. They believe that their procurement personnel will work more efficiently with PALT standards as oppossed to none. This confirms the Logistics Management Institute findings (7) that PALT standards are required:

> . . .for three reasons: (1) Individuals are not all motivated at the same gear - I may think that 30 days is excessive to issue a sole source purchase order, while you may think that 30 days to perform the same action is reasonable; (2) competition is a motivator - and there will always be those who will compete to beat the established 'standards,' and (3) managers need a standard, gauge or goal, if you wish, against which to measure the effectiveness of the mission they are responsible for. Measuring accomplishments against PALT standards or averages, managers are able to plan, manage, direct and maintain control of the procurement process - the process by which they are able to accomplish their mission - because contracting is the vehicle through which the government conducts its business.

The review of literature revealed three major PALT studies (3, 4, & 7) which indicated that the length of PALT is rooted in existing laws and DOD regulations and that much of PALT is beyond the control of individual procurement offices. However, all three studies firmly demonstrated that PALT can be reduced.

It is imperative to remember that PALT cannot be reduced beyond a certain point without sacrificing good business purchasing practices. A certain period of time is definitely required to effect a quality procurement action.

In summary, it seems that the MSCs that have achieved the shortest PALT times have performed a detailed in-house analysis of the procurement proces in order to establish time standards, a system of control and related reports to monitor PWD processing. It appears that when detailed processing standards are set at the MSC level and the contract specialist knows what is expected of him and how he will be rated, he will be more productive and try to meet the PALT standard. Lack of management controls could lead to excessive PALT.

IDENTIFICATION OF TIME SEGMENTS OF PALT WHERE MANAGEMENT ATTENTION SHOULD BE CONCENTRATED

As a result of the field interviews with procurement managers, it was concluded that certain segments of PALT are more readily manageable, controllable, and account for a larger portion of time than others. The literature search revealed that, in the past, PALT was one of the areas being reviewed under the Logistics Performance Measurement and Evaluation System (LPMES), DOD Instruction 5010.25. PALT data from the LPMES system has been summarized to show which specific processing steps of the pre-award procurement cycle take the most time. This information indicated to management where emphasis, in order of priority, should be placed in order to manage PALT (5). Table 1 summarizes the Army's PALT data broken out by method of procurement for fiscal years 1971, 1972, and 1973.

Tables 2 and 3 summarize the ranked percentages of each phase of the pre-award procurement cycle for formal advertising and negotiation. Table 2 illustrates that the pre-solicitation phase ranks first for formal advertising and accounts for 25.4 percent of PALT. Ranking second is the solicitation phase, which accounts for 22.3 percent of the PALT. Thus, the pre-solicitation and solicitation phases of the PALT cycle account, on the average, for approximately 50 percent of the total PALT for formally advertised contracts. Procurement's prerogatives regarding solicitation time are influenced by general ASPR rules for bidding time for formal advertisement. Thus, it might be concluded that the primary area on which managers should concentrate their attention in formal advertising is the pre-solicitation phase.

Table 3 for negotiated contracts shows that solicitation time ranks first and accounts for 26 percent of the PALT. Thus, it should receive management attention because in general, procurement has more discretion as to the time allowed for proposal preparation. The second highest ranking phase for PALT in negotiated contracts is the time required to perform the evaluation/analysis, which accounts for 25.1 percent of the PALT. Thus, it can be seen that the solicitation and evaluation/analysis phases account for slightly more than 50 percent of the PALT for negotiated contracts.

TABLE 1

PALT (ARMY)*

(IN CALENDAR DAYS)

Phase of the Pre-award Procurement Cycle	METHOD OF PROCUREMENT							
	FA				NEG			
	71	72	73	TOTAL	71	72	73	TOTAL
Procurement Request Review	50	27	1	78	8	14	8	30
Pre-Solicitation	44	29	42	115	16	48	17	81
Solicitation	35	35	31	101	50	36	45	131
Evaluation/ Analysis	30	14	27	71	41	37	48	126
Negotiation	--	--	--	--	15	20	22	57
Award Processing	35	39	13	87	16	29	33	78
Overall PALT	194	144	114	452	146	184	173	503

*SOURCE: LPMES, Army PALT data for FY's 71, 72, 73

TABLE 2

COMPONENT PARTS OF THE PRE-AWARD PROCUREMENT CYCLE WHICH ACCOUNT FOR LARGEST PERCENTAGE OF THE TIME IN THE PRE-AWARD PROCUREMENT CYCLE FOR FORMALLY ADVERTISED CONTRACTS

RANK	PHASE OF THE PRE-AWARD PROCUREMENT CYCLE	FORMALLY ADVERTISED CONTRACTS %	FORMALLY ADVERTISED CONTRACTS CUM %
1	Pre-Solicitation	25.4	25.4
2	Solicitation	22.3	47.7
3	Award Processing	19.3	67.0
4	Procurement Request Review	17.3	84.3
5	Evaluation/Analysis	15.7	100.0

TABLE 3

COMPONENT PARTS OF THE PRE-AWARD PROCUREMENT CYCLE WHICH ACCOUNT FOR THE LARGEST PERCENTAGE OF THE TIME IN THE PRE-AWARD PROCUREMENT CYCLE FOR NEGOTIATED CONTRACTS.

RANK	PHASE OF THE PRE-AWARD PROCUREMENT CYCLE	NEGOTIATED CONTRACTS	
		%	CUM %
1	Solicitation	26.0	26.0
2	Evaluation/Analysis	25.1	51.1
3	Pre-Solicitation	16.1	67.2
4	Procurement Request Review	15.5	82.7
5	Negotiation	11.1	94.0
6	Award Processing	6.0	100.00

The other thing interesting to note from Table 1 is that the three-year average overall PALT for both formally advertised contracts and negotiated contracts is about the same, but the component parts of pre-award procurement cycle do not rank the same insofar as which phase of the pre-award procurement cycle takes the most PALT.

ELIMINATION OF BOTTLENECK AREAS CAUSING PALT DELAY

The data collected from the automated PALT report relative to reasons for PALT delay was summarized, analyzed to determine if significant patterns between MSCs existed, and discussed with field personnel (2). This portion of the study was undertaken to uncover any significant patterns as to where and why PALT delays are occurring. The results highlight bottleneck areas (specific processing steps) which require management emphasis.

Tables 4 and 5 summarize the predominant reasons why the PALT standards were not met. The PALT delay codes have been ranked in order of frequency of occurrence. Examination of the delay code data on the PALT reports indicated that some MSCs do not report delay codes. Additionally, it was observed that there seems to be no current management use being made of the delay code data. Table 4, the summary of the PREDOMINANT reasons why PALT standards under $10,000 were not met, shows that four delay codes were apparently erroneously reported on some 18 occasions. These codes are: 22, Solicitation review board required; 23, Awaiting secretarial determination and finding; 34, Pre-award survey required on prospective contractor; and 37, Audit of contractor cost/price data delayed.

TABLE 4

FY 75 Summary of Predominant Reasons Why PALT Standard was not Met in HQ Agency (PWDs under $10,000, PALT Report)

Delay Code *	F	Rank
55	36	1
2	32	2
37	13	3
52	12	4
26	11	5
12	8	6
40	7	7
11	3	8
21	3	8
34	3	8
3	1	9
16	1	9
22	1	9
23	1	9
25	1	9
41	1	9

*Legend: PALT Delay Codes

2 - additional funds required
3 - additional program authority required
11 - specifications and drawings not adequate
12 - item part number or stock number in error and requires correction
16 - justification for sole source procurement not adequate
21 - solicitation cancelled
22 - solicitation review board required
23 - awaiting secretarial determination and finding
25 - proposed procurement action appealed by SBA prior to award of contract
26 - no response to solicitation
34 - pre-award survey required on prospective contractor
37 - audit of contractor cost/price data delayed
40 - extended period of time for negotiation required
41 - change in requirements prior to award
52 - unrealistic target date established
55 - excessive workload

FY 75 Summary of Predominant Reasons Why PALT Standard was not Met in HQ Agency (PWDs over $10,000, PALT Report).

Delay Code *	F	Rank
2	41	1
55	33	2
40	23	3
26	13	4
52	12	5
34	7	6
41	7	6
30	6	7
37	6	7
11	3	8
20	2	9
25	2	9
10	1	10
22	1	10

*Legend: PALT Delay Codes

2 - additional funds required
10 - specifications and drawings not available
11 - specifications and drawing not adequate
20 - solicitation closing date extended due to changes
22 - solicitation review board required
25 - proposed procurement action appealed by SBA prior to award of contract
26 - no response to solicitation
30 - low offeror determined non-responsible, and another pre-award survey required
34 - pre-award survey required on prospective contractor
37 - audit contractor cost/price data delayed
40 - extended period of time for negotiation required
41 - change in requirements prior to award
52 - unrealistic target date established
55 - excessive workload

While these situations could perhaps occasionally occur for PWDs under $10,000, it is doubtful that they would occur with such frequency as to become predominant reasons for PALT delay. This, together with the fact that some MSC's reported the same delay codes month after month, leads to the question, are these data realistic?

Table 4 for PWDs under $10,000 shows that delay code 52, "excessive workload," was the primary cause for PALT delay, with code 2, "additional funds required; award delayed pending receipt of additional funds" ranking second.

Table 5 for PWDs over $10,000 shows that delay code 2, "additional funds," ranks first, delay code 55, "excessive workload," ranks second; and delay code 40, "extended period of time for negotiation required," ranks third as the predominant reasons for delay in PWDs over $10,000 in FY 75.

The reasons for procurement delay were further analyzed to see if there were significant causes for delay occuring only in PWDs under $10,000 (i.e., were delays related to dollar size of PWD?) Analysis showed that the only item of significance appearing solely in PWDs under $10,000 was code 12, "Item Part Number or Stock Number in error and requires clarification." This is an understandable reason due to the large number of PWDs under $10,000.

For PWD's over $10,000 only one delay code occurred with significant frequency to mention; i.e., code 30, "Low Offeror determined non-responsible and another pre-award survey required."

IDENTIFICATION OF VARIABLES THAT AFFECT PALT

The tree diagram was chosen as a basis for displaying the PALT data collection plan, since it would enumerate all of the logical possibilities of variables affecting PALT where each combination of these variables could occur in a finite number of ways.

The next step was to identify varibles that would potentially affect PALT. Based on the review of literature and expert opinion, the following set of variables was identified to be the key variables that would potentially affect PALT. These variables were used to stratify and collect PALT data; the six MSCs, method of procurement (Formal Advertising (FA) or Negotiation (Neg)), contract dollar value $10,000 to $99,999, $100,000 to $999,999 and greater than or equal to $1,000,000) and type of contract (Fixed Price (FP)) or (Cost Reimbursement (CR)). Figure 2 illustrates the nested design breakout for this data collection plan with the distribution of the agencies' FY 75 contracts.

The assumptions behind this breakout were that: (1) each MSC is reflective of the type of equipment if buys, (2) FA vs Neg would be somewhat reflective of the phase of the life cycle, (3) the dollar size of the contract would be somewhat reflective of the complexity of the supplies being purchased, and (4) the type of contract (FP vs CR) associated with the negotiated contracts would be further reflective of the phase of the life cycle (production vs R&D).

Also, it should be noted from Figure 2 that there are six cells with less than four contracts per cell. These definitely are not large enough samples with which to establish statistically valid standards. Since so few contracts are awarded in these cells, separate PALT standards for PWDs in these areas would not be justified. These facts were ascertained by the examination of the contract distribution prior to collection in order to heueristically determine which variables explain the differences in PALT.

Also, the HQ Command's FY 75 contract distribution was analyzed to test whether PALT standards would be required for two-step formally advertised procurements. A reason for potentially eliminating two-step IFBs was that they normally have much longer PALTs than regular formal advertising and thus would tend to distort the data base. Analysis of the number of two-step IFBs awarded in FY 75 yielded two findings. First, a total of five two-step IFBs were awarded in FY 75 and second, only three MSCs used two-step IFBs at all. Obviously, those MSCs not using two-step IFBs would not need a separate PALT standard and since there were so few two-step IFBs awarded in FY 75, there is no need to establish PALT standards for two-step IFBs at all. However, in view of the recent increase of two-step formally advertised contracts awarded from five in fiscal year 1975 to 58 in fiscal year 1976, it is considered appropriate for the present to keep the current PALT standard for two-step formally advertised contracts.

Letter contracts were eliminated from the data base being used to establish PALT standards since the PALT for these contracts is very small by definition and their use is likewise infrequent.

FIGURE 2. DISTRIBUTION OF COMMAND CONTRACTS FOR FY 75 BY METHOD OF PROCUREMENT, CONTRACT $ VALUE, TYPE OF CONTRACT AND MSC.

HQ	METHOD OF PROCUREMENT	CONTRACT $ VALUE	TYPE OF CONTRACT	MSCs* - # Ks A	B	C	D	E	F
COMMAND #8,713	FORMAL ADVERTISING #3,407 %39	$10,000-99,999 #2,873 %84	FP #2,873 %100	994	403	177	134	1,119	46
			COST #0 %0	0	0	0	0	0	0
		$100,000-999,999 #484 %14	FP #484 %100	184	64	23	11	182	2[illegible]
			COST #0 %0	0	0	0	0	0	0
		≥ $1,000,000 #50 %2	FP #50 %100	17	2	1	2	25	3
			COST #0 %0	0	0	0	0	0	0
	NEGOTIATION #5,306 %61	$10,000-99,999 #4,089 %79	FP #3,590 %86	479	370	832	668	1,144	9[illegible]
			COST #599 %14	144	46	156	171	42	40
		$100,000-999,999 #917 %17	FP #659 %72	157	33	175	95	184	1[illegible]
			COST #258 %28	50	13	69	100	12	1[illegible]
		≥ $1,000,000 #200 %4	FP #157 %78	57	10	36	20	23	11
			COST #43 %22	11	6	7	13	3	3
			TOTAL	2,093	947	1,476	1,214	2,734	249
			%	24	11	17	14	31	3

A final premise was that the workload (PWDs) under $10,000 as represented by the number of PWDs was greater than the workload over $10,000 but did not consume the majority of manpower (man-days). For FY 75, it was found that 78 percent of the workload (PWDs) was under $10,000 but they consumed only 33 percent of the manpower at the MSC's.

An analysis of variance was used on the nested stratified design, Figure 2, as a means of determining if PALT differs statistically on the average between MSCs, dollar value, method of procurement, and type of contract. This analysis was done to determine which of these factors affect PALT. Also, if PALT were found to differ among factors, separate PALT standards for PWDs in these areas would need to be established.

The analysis of variance and non-parametric tests showed that at least two variables, method of procurement (FA vs Neg) and MSC's, have a significant effect on PALT. Thus separate PALT standards should be set for each MSC and within each MSC there should be two PALT standards for PWDs established (one for formal advertising and one for negotiation). The other finding of major significance from this analysis was that neither contract type (fixed price or cost reimbursement) nor dollar size seem to have a significant effect on PALT. In other words, the PALT seems to be about the same for fixed price contracts as for cost reimbursement contracts and for the three dollar stratifications ($10,000 to $99,999, $100,000 to $999,999, and greater than or equal to $1 million).

ESTABLISHMENT OF PALT TARGETS AND STANDARDS

The first step is to establish a cumulative frequency distribution for both formally advertised (FA) and negotiated (Neg) contracts at each MSC. For illustration purposes in this article, only an overall HQ Command target and standard will be established. Figure 3 is a graphic representation of the distribution for PALT for the HQ Command FY 75 PWDs. From Figure 3 one can see that it takes 221 days to award 85 percent of the HQ Command's PWDs. Assume that 85 percent would be the target percentage and 221 days would be the standard, but a challenge factor (e.g., 5 percent) is desirable. First subtract 5 percent from the target 85 percent and get 80 percent. Then look for 80 percent on Figure 3 to see the number of days it takes to award 80 percent of HQ Command's PWDs and read 200 days. Thus, for a target of 85 percent, the standard becomes 200 days. It can be seen that only 80 percent of HQ Command's PWDs are currently being awarded in 200 days and 85 percent will be required. Therefore, there is a challenge to do better; i.e., to award 85 percent of the PWDs within 200 days.

MANAGEMENT ANALYSIS AND DISPLAY OF STATISTICAL INFORMATION ON PALT

This part of the article will describe what a PALT manager at a HQ Command should do to track and analyze PALT performance in order to (1) determine the extent to which the MSC's met the PALT targets; (2) determine reasons for non-attainment when PALT targets are not met; and (3) initiate corrective assistance/action as necessary.

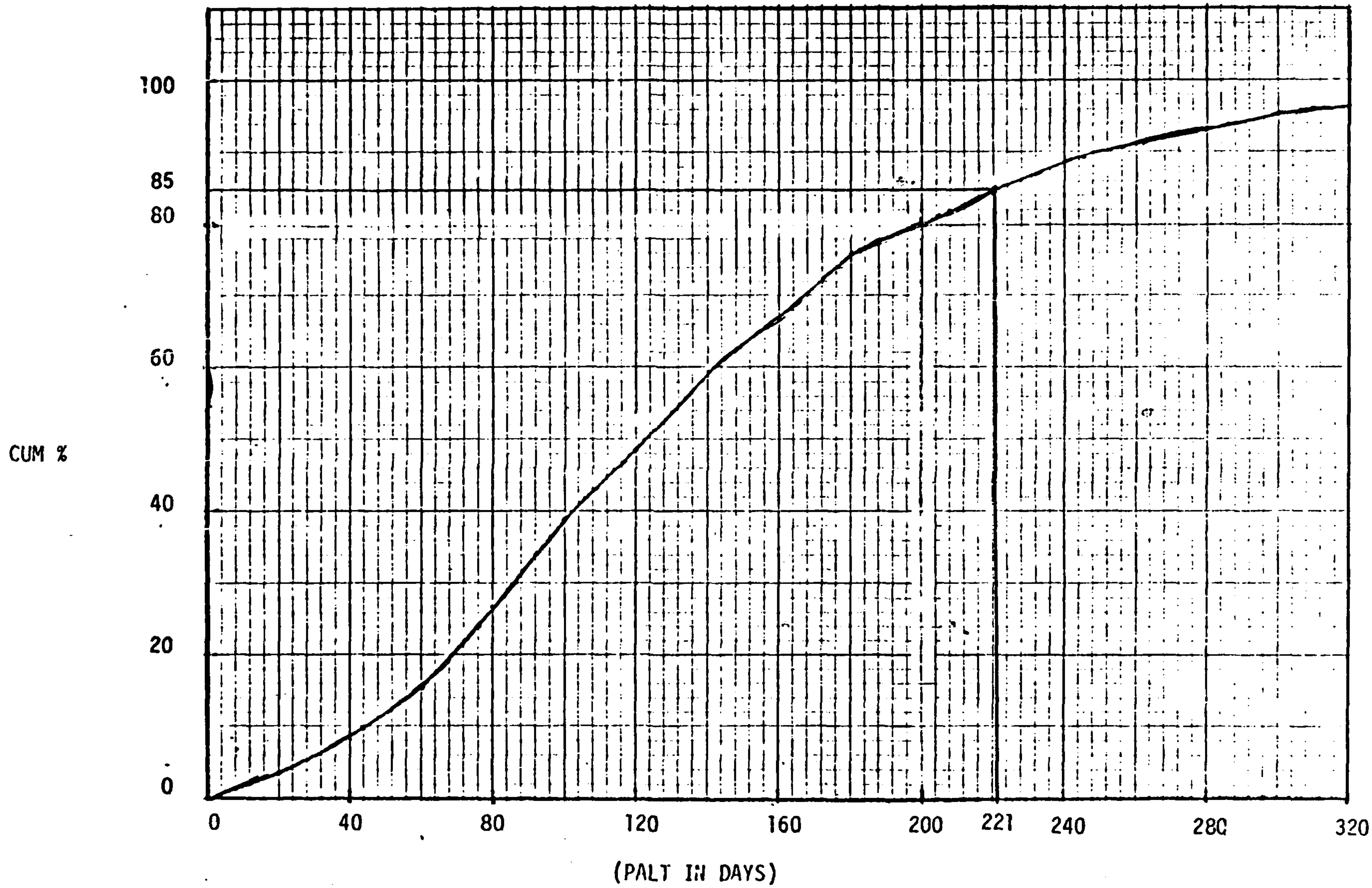


FIGURE 3. CUMULATIVE FREQUENCY DISTRIBUTION OF PALT FOR HQ AGENCY FY 75 PWDs.

First, one must identify the variables which affect the PALT objective or indicate the achievement of the PALT objective. These variables are: (1) the number of PWDs awarded per month meeting a PALT standard for an area,* (2) the total number of PWDs awarded per month for a PALT area, (3) the average PALT and sample standard deviation for a given PALT area, (4) a list of reasons why the PALT target for an area was not achieved and the frequency of the reason for non-achievement, (5) manpower available to process PWDs for the report period, and (6) the workload (number of PWDs) to be processed during the report period.

The second step is to use the variables which indicate PALT achievement to develop a performance indicator (PI). By using two PALT variables, (1) number of PWD awards at an MSC meeting the PALT standard for a given area and (2) the total number of PWDs awarded at an MSC for the same given area, a PI can be formulated into a mathematical expression as follows:

$$\underset{\text{(PALT)}}{\text{PI}} = \frac{\text{\# of PWDs awarded within the standard (MSC, FA or Neg) X 100}}{\text{Total \# of PWDs awarded (MSC, FA or Neg)}}$$

$$= \text{Percent of PWDs awarded within the standard (MSC, FA or Neg)}$$

The third step is to determine if an MSC met the PI for the quarter.

*There are two "areas" for each MSC, one for formal advertisement and one for negotiation.

The PALT target is considered to have been met for a quarter if the

$$\text{PI (PALT), (MSC, FA or Neg)} = \frac{\text{\# of PWDs awarded} \leq \text{Std}}{\text{\# PWDs awarded}} \times 100 \geq \text{\% Target}$$

for MSC, FA or Neg. If the PI (PALT) met or exceeded the PALT target, no action is necessary. Likewise, if the PI (PALT) did not meet the target (85%) but met or bettered 80% (the lower tolerance limit) no immediate action is required. If the PI did not equal or exceed the 80%, lower tolerance limit, the PALT target was not met. In this case, an indepth evaluation of PALT achievement/nonachievement is required to ascertain exactly what is happening so as to be better able to manage PALT. This evaluation would begin with the computation of actual performance to determine by how much the standard was missed. Next, look for reasons why the standard was not achieved: (1) evaluate reasons for nonachievement as an indicator, (2) look at workload and available manpower, and (3) look for other factors that may have caused performance to slip.

After obtaining this information, the MSC PALT manager should be contacted to discuss the findings as to why the specific PALT target was missed. The HQ PALT manager should take corrective actions on PALT targets missed, such as, (1) a letter to the MSC indicating what must be done to improve PALT, and (2) take additional steps to help MSC improve PALT (e.g., have Director of P&P contact another directorate in HQ if a PALT code indicates that PALT non-achievement was really their responsibility and request that directorate take corrective action).

PALT achievement trends should be recorded so that the results can be tracked and can be used to prepare summary management reports along with charts to brief top management each quarter. Types of PALT management information to be displayed are: (1) Summary chart of actual performance (illustrated in Table 6), a method of displaying whether or not the MSC achieved the PALT targets, (2) Summary chart of reasons for PALT delay (Table 5), illustrates how data on reasons for PALT delay should be analyzed and presented to top management, and (3) Summary charts of trends for MSC's and overall PALT performance (Figures 4 and 5) illustrate how one might present performance over time (e.g., improvement or worsening of PALT achievement).

The HQ PALT manager must use his judgement in working with PALT data and must determine if and when other types of PALT mangement reports are needed. Also, the PALT management reports can be compiled by the computerized management information system as appropriate.

CONCLUSIONS

1. The establishment of valid PALT standards is a useful and necessary management technique which will encourage award of PWDs in a timely manner provided that performance is evaluated on a regular basis.

2. The PALT delay codes are essential to good PALT management. The most frequent reasons for PALT delay are in fact of equal, if not greater, importance than the PALT standards themselves, in that the delay codes identify bottlenecks which, if corrected, would minimize PALT.

TABLE 6. MSC'S PALT PERFORMANCE FOR THE 1st QUARTER OF FY 77 (PWDs ≥ $10,000)

MSC	FA PWDs Target (%) (200 days)	Actual Achievement	Target was			Neg PWDs Target (%) (215 days)	Actual Achievement	Target was		
			Met	W/1 tol	Not Met			Met	W/1 tol	Not Met
A	72	73	X			86	87	X		
B	55	56	X			74	78	X		
C	92	91		X		81	80		X	
D	(140^{85}days)	87	X			96	96	X		
E	99	96		X		94	86			X
F	98	90			X	99	97		X	
HQ	(209^{86}days)	87	X							

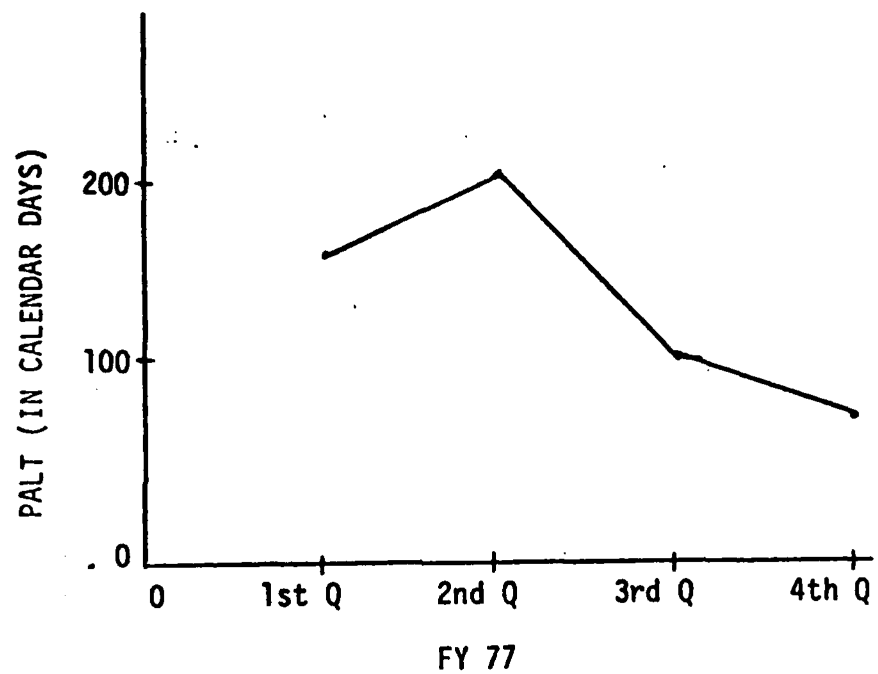


FIGURE 5. AVERAGE PALT FOR HQ AGENCY.

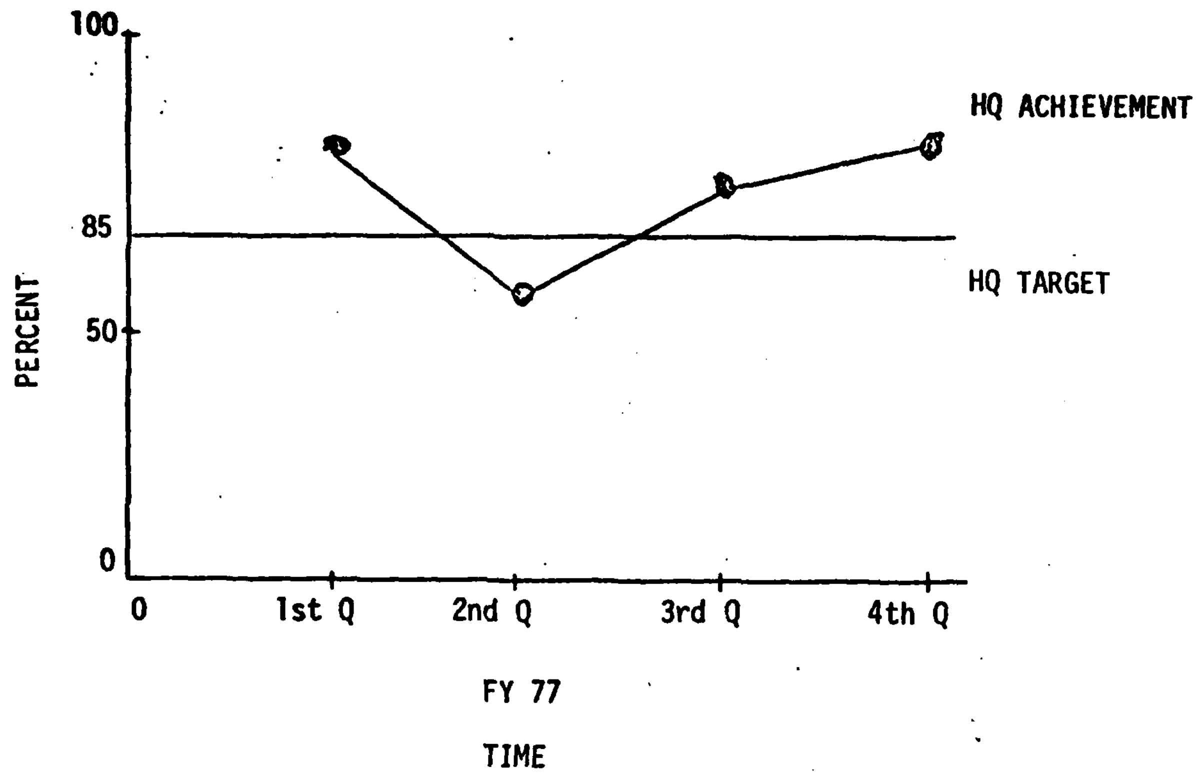


FIGURE 4. HQ PALT PERFORMANCE OVER TIME.

3. The current definition of PALT needs to be expanded to include the HQ management information system methods of generating and tracking PWDs.

4. Procurement managers would derive great benefits from employing statistical methodology to develop future PALT standards and to evaluate performance against those standards.

5. PALT is statistically significantly different at each MSC and between methods of procurement (Formal Advertising vs Negotiation).

6. PALT is not statistically significantly different for fixed price contracts as opposed to cost reimbursement contracts. Nor is PALT significantly different between the three dollar stratifications tested.

7. In view of the increase in the number of two-step formally advertised contracts from fiscal year 1975 to fiscal year 1976, it is considered appropriate for the present to keep the current PALT standard for two-step formally advertised contracts.

8. Certain segments of PALT account for varying portions of time during the pre-award procurement cycle depending on whether the procurement is formally advertised or negotiated. For formally advertised procurements, the pre-solicitation and solicitation phases account, on the average, for approximately 50 percent of the total PALT. For negotiated procurements, the solicitation and evaluation/analysis phases account for slightly more than 50 percent of the total PALT.

9. The major portion of PALT management should be concentrated on PWD's over $10,000, although PWD's under $10,000 accounted for 78 percent of the total PWD's processed in FY 75, only 33 percent of the manpower was devoted

to these PWD's. They also accounted for only approximately 2 percent of the total dollars awarded in FY 75.

RECOMMENDATIONS

1. The use of PALT standards should be continued throughout the Command.

2. Although PALT performance is reported on a monthly basis, the MSC's PALT achievement towards meeting the PALT standards should be assessed only on a quarterly basis due to the inherently large standard deviation in PALT.

3. PALT standards should be reviewed and updated every year, based on actual performance during the previous 12 months. This is feasible with computer management information system.

4. PALT performance should be displayed so as to show trends both within the fiscal year and among fiscal years. When PALT performance is felt to be at a level consistent with good business practices, the emphasis on PALT should be reduced.

5. A detailed analysis of the PALT delay codes should be conducted quarterly. Appropriate action should be taken to reduce or eliminate the most frequent reasons for PALT delay.

6. PALT regulations should be updated to provide an expanded PALT definition which should incorporate the capabilities of the PALT management information system.

7. Procurement managers should consider utilizing the statistical methodology employed in this report as the method for developing future PALT standards and evaluating performance against the standards. The best way of implementing this methodology is to initiate a system change request to the existing PALT management information system delineating the additional uses of the data generated. The specific statistical methods which proved most useful were frequency distribution, test of hypothesis, and analysis of variance.

8. Separate PALT standards for Formal Advertised and Negotiated PWDs should be established for each MSC.

9. The current PALT standards for two-step formally advertised contracts should be kept until the upward trend in use of two-step IFBs from fiscal year 1975 to fiscal year 1976 can be assessed. If this upward trend does not continue, the need for a separate standard should be reassessed.

10. Procurement managers should concentrate their attention on those segments of the pre-award procurement cycle which account for the largest portion of PALT.

11. Procurement managers should concentrate their attention on those PWDs where the bulk of the manpower and dollars are devoted, above $10,000. However, the procurement manager must remember his responsibility for the successful completion of the overall program.

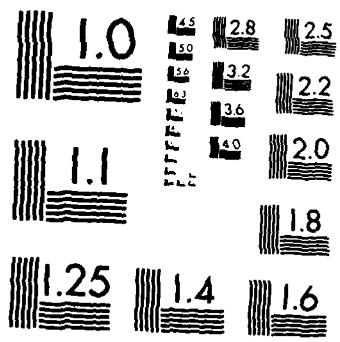
WRAP UP

This article evaluated current PALT practices in terms of their validity, usefulness and cost. The article provides procurement managers with a valid set of PALT management criteria against which to measure the effectiveness of the mission for which they are responsible. Thus, by measuring accomplishments against PALT management criteria, procurement managers will be able to manage, plan, direct and control the pre-award procurement cycle.

Acknowledgement: The authors appreciate the assistance of Mr. Rachel Lilley, Procurement Analyst of the Army Procurement Research Office, in the preparation of this article.

AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76 2/7

UNCLASSIFIED F/G 15/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LITERATURE CITED

1. Army Regulation 310-25. Title: Dictionary of US Army Terms. Washington, D.C.: US Government Printing Office, June 1, 1972.

2. Automated Logistics Management Systems Agency. Procurement Aging and Staging System. Vol. 1, CCSSOI 18-715-101. September 1975.

3. Automation in Defense Procurement (Draft Final Report). OSD Task Group 3-73 of the Logistics Systems Policy Committee, September 1974.

4. Courtade, Lawrence M. Yvonne Ross. Management Assistance Study: Procurement and Production Directorate Administrative Lead Time - PWD Processing System. Warren, Michigan: Comptroller Management Analysis Division, TACOM, February 1975.

5. Logistics Performance Measurement and Evaluation System. LD 25391E. Washington, D.C.: Office of the Assistant Secretary of Defense, FYs 71, 72, & 73.

6. _____. Personal interview with Frank Kelsey, DRCPP-SO of DARCOM HQ, Alexandria, VA, June 4, 1976.

7. Procurement Time, Navy Complex Items. LD 11871. Washington, D.C.: Logistics Management Institute, December 1966.

8. Report of the Commission on Government Procurement. Vol. 1. Stock No. 5255-00002. Washington, D.C.: US Government Printing Office, December 1972.

9. US Army Materiel Command. AMC Regulation 5-4, Central Procurement Workloading Report (RCS AMCRP-127). 27 May 1975.

10. _____. Fy 75 Individual Procurement Action File (DD 350s). Letterkenny Army Depot, PA: US Army Materiel Command, Logistics System Support Agency, December 1975.

AN ANALYSIS OF COMPETITIVE BIDDING ON BART CONTRACTS

Kenneth M. Gaver
Jerold L. Zimmerman

November 1975

The research assistance of Barbara Rosenbaum and Arthur Keegan and the comments on an earlier draft by Lt. Colonel Daniel Strayer and Major Sanford Kozlen, USAF are gratefully acknowledged.

Research supported by the Air Force Business Research Management Center, United States Air Force, Wright-Patterson Air Force Base, Ohio, under contract F33615-75-C-5271. The results and views as expressed in this work are the sole responsibility of the authors and are not necessarily concurred in by the United States Air Force.

1. Introduction

The purpose of this study is to analyze the competitive bidding on the heavy construction projects of the San Francisco Bay Area Rapid Transit (BART) District.[1] We develop an analytical model that is appropriate for the study of the BART bidding experience, and use it to derive a number of propositions concerning the bidding behavior of the participating contractors. Given that we have data pertaining to 77 BART construction projects, we are in the position of being able to test statistically many of the propositions we derive.

There are at least two reasons which prompted us to undertake this study. First, because of a lack of good data, the empirical study of bidding environments has lagged the development of theoretically bidding models. Not only will our study help to remedy this situation, but it also serves to isolate data requirements for future empirical studies. Secondly, the theoretical treatment of bidding problems has tended to focus on developing strategies to be followed by the individual bidders; little attention has been given to the problems faced by the procuring agency itself. Our study identifies certain variables that affect the outcome of the bidding process, and in this regard provides the agency with information as to how to control the bidding environment.

The paper is organized as follows. In section 2, we provide the reader with some background information concerning the BART bidding environment. In section 3, we develop an analytic model of bidding behavior which we feel is relevant to the BART bidding experience. Using this model, we derive a number of propositions concerning the contractors. In section 4, we discuss the nature of the data base used in our empirical tests. Then in section 5, we describe the empirical model

[1]The authors wish to express their gratitude to Mr. Richard Shepard, Secretary to SF BART District for making the BART data available to us and for his assistance in answering a number of technical questions.

used and present the results of our tests. Finally, in section 6 we summarize the findings of our study.

2. The BART District Competitive Bidding Environment

As mentioned above, our study focuses on the competitive bids received by BART for the heavy construction contracts of the mass transit system. Specifically, we shall be concerned exclusively with the grade line segments, aerial line segments, subways, and stations of the system. We do not investigate the bidding on BART contracts for the trains, train control equipment, fare collection devices, parking lots, landscaping, supplies, or parts.

Construction of the 71 mile system was divided into some 77 contract packages. These ranged in size from a half million dollars to $ 94 M. The duration of the projects ranged from three months to three years, while bid dates were staggered from the middle of 1964 through the beginning of 1971.

In many ways the civil engineering aspects of BART were the most successful and least troublesome in terms of cost overruns and the ability of the completed contract to meet the pre-award specifications.[1] One possible explanation for this was the BART District's obsession to relieve the contractor of risk.[2] Among other things, the District assumed all cost overruns resulting from such unforeseen events as third party strikes, substantial buried obstructions in subway work, inflation resulting from increased wage rates and equipment rental rates, etc. BART also provided advance contracts for relocation of utilities, and the advance resolution of access and traffic maintenance conflicts. In addition, the District provided a co-ordinated insurance program to protect the construction contractor from any financial liability due to damages to adjacent

[1] C. Burck, "What Can We Learn from BART's Misadventures," Fortune (July, 1975).
[2] T.R. Kuesel, "BART Subway Construction," Civil Engineering - ASCE (March, 1969).

structures, etc. There was also a program which provided formal procedures for sharing savings resulting from contractor cost reduction proposals. But perhaps the most far-sighted activity, according to Kuesel, was

> "the assignment of a full time labor relations counselor to minimize labor disputes between the construction union and the contractors. This effort produced a formal systemwide BART Labor Agreement, to which all unions and contractors engaged on the project became parties, providing for handling of grievances. This move ... kept the loss of time because of strikes to a record low rate for a project of BART's size and complexity."

The net result of these efforts was to reduce disputes and contingencies allowed for in the bids.

Another aspect of the BART bidding environment was the District's effort to promote bidding competition. The formula used by the District actually arose as the result of the so-called "Black Christmas" misadventure. Originally, the plan had been to carve up the system into relatively large project packages in an effort to attract bids primarily from the "major qualified contractors." When the bids were opened in late 1965 for the Oakland subway contract, BART's first major project, the results were disastrous. Only two contractors submitted bids, with the lowest bid exceeding the estimated costs of $47 million by some $13 million.

To remedy the problem, the District threw out the two bids, redesigned the section, eliminating certain portions, and redivided the Oakland subway into 5½ projects. On the second round, a total of 20 bids were submitted, with the low bids totalling to $48 million. As a result of this experience, the District adopted the policy of limiting contract size where possible to less than $10 million. Coupled with an active pre-bid publicity program, this action resulted in BART attracting bids on subsequent contracts from a diverse set of contractors, ranging widely in size and geographical location. All told there were 458 bids received on the 77 contracts or roughly six bids per project.

For each contract an advanced notice was published encouraging contractors to submit bids. Two weeks before bid submission, a pre-bid conference for plan holders was held to answer any remaining questions. Just prior to the bid opening, the consulting engineers (Parsons, Brikenhoff-Tudor-Bechtel, PBTB) who did most of the design work submitted an engineer's estimate. The contract, according to California state law, had to be awarded to the low bidder unless all bids are disqualified.

Another important aspect of the BART bidding environment was the bonding requirement imposed on all public works projects in California. Two bonds, a performance bond of 100% of the contract price and a 50% labor and materials bond, were required. If the contractor failed to complete the project, the surety company was obligated to complete the project.[1] Generally, the surety company bonds a contractor for between five and twenty times net worth depending on the contractor's past performance at a fee of roughly .6% of the bond per year. The bonding procedure seemed to affect bidding behavior in several ways. First, it raises the average amount bid due to the bonding fee and secondly, it encouraged the formation of joint ventures[2] to avoid using all of a firm's bonding capacity on one job.[3]

The BART bids were unit price tenders whereby the contractor was reimbursed at his estimated unit price for the actual work performed on the variable quantity line items. For example, if the estimated quantity of excavation was 10,000 cubic yards for which the low bidder priced it at $2 per cubic yard or $20,000, but the actual amount of excavation turned out to be 12,000 cubic yards, the

[1]Out of 77 contracts, no contractor failed to complete a project.

[2]Joint ventures are formed also to share risk and assemble the various skills to meet the contract's specifications.

[3]To the extent that the contract can diversify away some risk across construction contracts, then by being limited on the number of contracts he can accept due to the bonding constraint, he incurs under-diversification costs which are eventually reflected in his bids.

contractor is reimbursed for $24,000. This also had the effect of reducing contractor risk.

The final aspect of the environment was the way in which BART used progress payment arrangements to reduce the financing costs borne by the contractor. Each month, up until the project is 50% complete, BART retained 10% of each progress payment to be repaid upon completion and acceptance of the project. Each monthly progress payment was determined to be 120% of the contractor's labor cost (gross wages up to and usually including foreman) and 115% of the materials and equipment rental costs. Once the project was over 50% complete the BART District could, at its option, eliminate the 10% retention. Although a number of interesting empirical tests could have been conducted concerning this feature of the BART bidding environment, we did not have data on the actual progress payments made to the individual contractors.

3. Analytic Model

There is an extensive literature on competitive biddingmmodels spanning the areas of Economics, Finance, Operations Research/Management Science and Civil Engineering. But, surprisingly enough, only a small number of these studies offer any guidance as to how to model the bidding behavior of a BART contractor. These are Hanson and Menezes, Baron, and Ederington.[1]

Based partially on these papers, we have constructed the following model of bidding behavior assuming expected profit maximization.

[1]Baron, D.P., "Incentive Contracts and Competitive Bidding," American Economic Review, (June, 1972). Baron, D.P., "Probabilistic Expectations and Bidding Behavior," Working Paper, Northwestern University, (October 1974). Ederington, L.H., "Uncertainty, Competition, and Costs in Corporate Bond Underwriting," Journal of Financial Economics, (June, 1975). Hanson, D.L. and Menezes, C.F., "Risk Aversion and Bidding Theory," in Papers in Quantitative Economics, edited by J. Quirk and A. Zarley, University Press of Kansas, Lawrence, (1968).

(4) $$V = \max_{B} \{(1-F(B))[R+B-E_{\tilde{x}}c(\tilde{x}+y;\ S,L,JV,P)] + F(B)[R-c(y)]\}$$

where

B — the bid price prepared and submitted by the bidder.

x — a vector of inputs (i.e., labor, materials, equipment) needed to meet the design specification on the contract. Since the exact quantity of labor or equipment time is not known with certainty, the vector is written as a vector of random variables.

y — the input vector necessary to complete the bidder's existing work. y is assumed to be known with certainty.

F(B) — the probability of losing the contract (i.e., the probability that someone submits a lower bid)

$$F(B) = \int_0^B f(b)\,db$$

R — the expected revenues the bidder will receive from his existing work. R is assumed to be known with certainty.

$E_{\tilde{x}}c(\tilde{x}+y;\ S,L,JV,P)$ — the expected cost function of using the vector of inputs denoted by x+y, given the size of the bidder is S, the duration of the project is L, the bidder is a joint venture of JV firms, and a factor price vector of P.

In this model, the bidder maximizes the expected profit from the contract given profit from existing contracts of R-c(y). The prices of the factor inputs are assumed to be known with certainty.

The profit maximizing bid must then satisfy the following first order condition:

(5) $$B = [E_x c(x+y;\ S,L,JV,P) - c(y)] + \frac{1-F(B)}{f(B)}$$

Using this first order condition, a number of analytic results can be derived. (See Appendix B for the derivations.)

Proposition 1.

If marginal costs are increasing (decreasing), then an increase in other work increases (decreases) optimal bid price. Or, $\frac{\partial B}{\partial y} > 0$, if $\frac{\partial^2 c(\tilde{x}+y)}{\partial y^2} > 0$ and $\frac{\partial B}{\partial y} < 0$ if $\frac{\partial^2 c(\tilde{x}+y)}{\partial y^2} < 0$.

The contractor's bid depends on (1) how much other work he has, y, and (2) whether his marginal costs are increasing or decreasing.

Proposition 2.

If marginal costs are decreasing in firm size, then larger firms submit lower bids. Or $\frac{\partial \left[\frac{\partial c(z)}{\partial z}\right]}{\partial S} < 0$ implies $\frac{\partial B}{\partial S} < 0$. The larger bidder is more vertically integrated and has a greater number of concurrent construction projects. Both of these factors lower his marginal costs.

Proposition 3.

If marginal costs are decreasing in expected project duration time, then longer construction projects allow greater opportunities for interleaving factor inputs on concurrent projects.

Proposition 4.

Increases in factor input prices raise marginal costs and bid prices.

Proposition 5.

Increases in the number of firms in the joint venture submitting the bid lowers marginal costs and bid prices. Construction firms form syndicates (joint ventures) up to the point that the marginal benefits from risk sharing, task specialization, and relaxation of bonding constraints are equated to the marginal costs (the increased control and coordination of the syndicate). Additional members will be added to the joint venture as long as the new member can lower construction costs (and thus bid price) in excess of the additional coordination costs.

Proposition 6.

If the bidder faces n identical competitors, then the optimum bid price varies inversely with n.

4. The BART Data Base

For each of the 77 construction contracts, we had information concerning not only the winning bid (denoted by BID_{j1}) but also all the losing bids (denoted BID_{j2}, BID_{j3}, ...,BID_{jN_j}). In addition, we had the engineer's estimate of contract cost, actual project duration, the identities of the participants of each joint venture, etc. A summary of the data available is given in Table 1.

Table 1

Summary of Data
($j=1,2,\ldots,77$ contracts)

Item	Abbreviation
Date of bid submission	$BDATE_j$
Date of Project completion	$CDATE_j$
Engineer's Estimate of Contract Cost	EE_j
Number of bids submitted on the contract	N_j
The name of each venture submitting a bid	$NAME_{ji}$
The amount bid by each venture $i=1,2,\ldots,N_j$	BID_{ji}
The number of individual construction firms in the joint venture submitting the bid	JV_{ji}
Length of Contract ($CDATE_j$ - $BDATE_j$)	L_j
Total construction signed in year y by firm i $y=1960,1961,\ldots,1971$	$SALES_{iy}$
Quantity of Portland Cement shipped to the Western States in month m of year y	$CEMENT_{my}$
Number of workers employed in construction in month m of year y	EMP my

Since this study relies heavily on the engineer's estimate, it may be worthwhile to discuss our assumptions concerning this variable. First, we assume this estimate is uncontaminated by knowledge of the bids to be received since it is prepared and delivered before the sealed bids are opened. We also assume the bidders did not have knowledge of the estimate in prepari their bids. In essence, we are assuming no collusion between PBTB and an f the bidders. Secondly, since it was prepared by PBTB, a consortium of e construction firms, we would expect the same techniques and procedu ed to prepare the bids were probably also used to prepare the estimate. 54% (76%) of all bids were within $\pm$ 10% ($\pm$ 15%) of the engineer's estimate on the 77 projects.

In addition to this BART data, we assembled data regarding individual construction firms and economic indices. It was rather prevalent on the BART contracts for syndicates of construction firms to form joint ventures. For each individual construction firm we tried to assemble data on their relative size using the <u>Engineering News Record</u>'s (<u>ENR</u>) annual list of the four hundred largest contractors. The <u>ENR</u> accumulates total contract awards including subcontracting each year and then publishes the list, usually in May of the following year. On the 77 contracts, 458 bids were received from 124 different joint ventures (venture x-y was assumed to be different from venture y-x). These 124 different joint ventures were the combination and recombination of 106 individual contractors. For these 106 firms we were able to assemble sales data (contracts signed) on 46 firms. In addition to the <u>ENR</u> data we used the Dun and Bradstreet, <u>Million Dollar Directory</u> and <u>Middle Market Directory</u> to obtain a few missing sales figures.

We could not obtain sales data on all the firms comprising the joint ventures, and therefore, we had to make some assumptions regarding the amount of work they were engaged in. Since their revenues were not reported in <u>ENR</u>'s top 400 nor in the Dun and Bradstreet Million Dollar Directory, we assumed an annual sales figure of one million dollars as an estimate of their sales.[1]

5. The Empirical Model and Tests

In section 3, we derived six propositions concerning the bidding behavior of the participating contractors. We now turn our attention to the empirical tests of those propositions.

On examination, we see that the expression for the contractor's optimal bid given by (5) is a fairly complex, non-linear function of the variables involved. Since we do not have enough information to specify this functional form, we adopt the simplifying assumption that (5) admits a local linear approximation and write our general empirical model as

$$(7) \qquad BID_{ji} = a_0 + a_1 EC_{ji} + a_2 \frac{1}{N_j} + \epsilon_{ji}$$

where

EC_{ji} is the expected incremental cost of undertaking project j as estimated by bidder i;

N_j is the number of bidders on project j;

ϵ_{ji} is an error term or the unexplained portion of bid price.

Since EC_{ji} in turn depends upon other factors as discussed in section 3, we elaborate more fully on our measurement of this variable.

5.1 Expected Costs

The bidders estimate their expected incremental costs for project j. Their expected cost will be a function of such factors as their current

[1]In a few instances, this assumption is known to be violated. Some of these contractors are divisions in larger firms. However, these "firms" are treated the same as though they were small, separate entities.

construction capacity, their efficiency, current prices for labor, equipment, and materials, etc. In formal terms,

(8) $EC_{ji} = EC_{ji}$ (capacity, efficiency, current prices, ...)

The capacity concept here is related to proposition P1 in section 3. Assuming that marginal costs are increasing, then as the firm approaches full capacity, its expected costs rise as does its bid price.

A contractor's capacity, as we use it here is most likely determined by the number of foremen or supervisors on his payroll. One would expect that a contractor with idle foremen would bid lower than if all foremen were busy and the addition of this project would require either existing foremen to work overtime or hiring new foremen. Thus, a contractor's expected incremental cost and hence bid price should depend on their existing work load, but trying to measure this relationship empirically imposes two severe problems. First, we do not have data on all the firms' existing and expected work, rather we only have information regarding their existing BART work. The second estimation problem is associated with the syndication process. Suppose a bid is received from a joint venture composed of three firms, A-B-X and that A is currently working on a $2M BART contract with firm C in a joint venture called, C-A, and X is working on a $1M BART project in joint venture X-Y-Z. How does one untangle these syndications and measure the degree of slack in joint venture A-B-X?

Our solution to the problem is to use a disaggregation-aggregation procedure (described in Appendix A) to measure the amount of outstanding BART work that joint venture i has at the time they bid on project j. We then determine capacity, CAP_{ji}, by dividing the amount of the venture's outstanding BART work by the size of the firms comprising the joint venture (as measured by their revenues over the last three years). This measure is rather crude since our revenue data is incomplete, the percentage completion is estimated as a linear trend using beginning and ending dates, and also we do not know the precise sharing arrangements used by individual firms in the joint ventures.

The next determinant of expected costs, EC_{ji} is the joint venture's efficiency. This is an extremely difficult concept to measure empirically. Conventional wisdom suggests that efficiency and size are related. However, the direction of the relationship is not clear. Small firms may be more efficient due to their lower overhead whereas larger firms may be more efficient due to their access to wider markets, returns to scale, etc. Fully realizing the unspecified nature of the causal model, we use the weighted sales of the joint venture, $SALES_{iy}$, as a proxy for returns to scale.

Another factor influencing the firm's cost estimate, EC_{ji}, is the general level of construction in the area at the time the contract was signed. We reasoned that if the construction industry was at or near full employment when a BART contract was to begin, then less skilled workers must be employed requiring more supervision, thus, driving up EC_{ji}. We used two proxy variables to try to capture this effect: the number of construction workers employed at the time of the bid (month m of year y), EMP_{my}, and also, the quantity of Portland Cement shipped to the Western states in month m of year y, $CEMENT_{my}$. Both of these factors, EMP_{my} and $CEMENT_{my}$, were included in order to capture the effects on the bids of general construction price shifts due to seasonal or economic effects of the construction industry being in an expanding or contracting period.

The major determinant of EC_{ji} is the cost and quantity estimates made by i for project j. Presumably, each bidder has a different EC_{ji}. The capacity, efficiency, and economic indicators, CAP_{ji}, $SALES_{ji}$, EMP_{my}, and $CEMENT_{my}$, explain <u>differences</u> among EC_{ji}, however, these variables do not explain the <u>level</u> of EC_{ji}. For example, CAP_{ji} being very high for a firm may increase costs and bids by 3%

but CAP_{ji} does not explain the scale or level of costs between a \$3M job and a \$30M job. Ideally, we would like a measure of each bidder's ex ante estimate of the scale of the project. Again limitations due to data availability precluded such a measure. However, the scale of the project had to be controlled for or else the regression results would be meaningless. In order to solve this problem we used the engineer's estimate, EE_j, which is not a joint venture specific proxy but rather a variable common to all the bidders on a given project.

There are several issues that arise from the use of EE_j. The engineer's estimate is prepared by the consulting engineers, PBTB, as an estimate of the bids to be received by the agency. EE_j was used by BART as an "independent" check on the bidders to prevent collusion and insure that the low bid was "reasonable." Thus, EE_j is an estimate of the full cost plus profit PBTB expected the low bidder to submit and EE_j is thus, not an estimate of the expected costs of the average bidder.

The syndication process is a very interesting and theoretically rich aspect of the BART bidding and heavy construction industry in general. As discussed earlier, firms form joint ventures in order to share the risks, to satisfy bonding constraints (and thus reduce underdiversification costs), and to assemble diverse skills and perhaps economies of scale in order to complete the project However, offsetting these benefits of syndication are the increased communication, monitoring and coordination costs involved in maintaining the syndicate. As our analysis of section 3 suggests, the larger the joint venture, the lower the expected incremental costs. Thus, we included as a very crude indicator of the syndication process just the number of firms in the particular joint venture submitting a bid, JV_{ji}. To account for the possibility that benefits of syndication may increase with the size of the job, we also include one further independent variable,

$$DJV_{ji} = \begin{cases} JV_{ji} & \text{if } EE_j \leq \$5M \\ 0 & \text{if } EE_j > \$5M \end{cases}$$

Finally, we include in our measurement of EC_{ji} the length of time needed to complete project j. This we denote by L_j. Longer contracts, ceteris paribus, may allow the contractor more opportunity for interfacing and interleaving the BART project into his other jobs thereby lowering his costs on the BART project. For example, equipment sharing or technician swapping between contracts may lower average costs, these arrangements are more probable on longer contracts, hence L and BID are inversely related.

In summary, instead of running the expected cost of project j by bidder i, EC_{ji}, in equation (7), which was impossible due to the fact that EC_{ji} was unobservable, we instead used eight different variables. Specifically, we substitute the following into equation (7)

$$(9) \qquad a_1EC_{ji} = b_1CAP_{ji} + b_2SALES_{ji} + b_3CEMENT_{my} + b_4EMP_{my} + b_5EE_j + b_6JV_{ji} + b_7DJV_{ji} + b_8L_j$$

5.2 Competition, $1/N_j$

The next independent variable in equation (7) to be considered is $1/N_j$. As suggested by proposition 6, each bidder should adjust his bid in response to his perceptions of the competition (by impounding in the hazard rate his expectations regarding how his competition will bid). If, as a simplifying assumption, all his competitors are assumed to be identical and independent then the analytic model simplified and the optimum bid submitted had to satisfy a function containing $1/N_j$.

Each bidder should have formed an expectation of N_j during bid preparation although N_j is revealed at bid submission. We are confident that N_j is known to all bidders prior to submission due to the following reasons. Two weeks prior to submission, there was a plans holder meeting at the BART offices whereby prospective bidders are acknowledged. In addition, the construction industry on a regional basis is very close knit, most contractors know quite a bit about their competitors including probably their bidding intentions on up coming projects. And finally, once a contractor starts to prepare his bid, a great deal of information is obtained through the possible subcontractors contacted during bid preparation. Therefore, it is highly likely that a bidder does have a reasonably accurate idea of the number and identity of his competitors on a given project.

5.3 The Empirical Results

Given the specification and assumptions embodied in equations (7) - (9), our empirical model is

$$(10) \qquad BID_{ji} = \beta_0 + \beta_1 EE_j + \beta_2 CAP_{ji} + \beta_3 L_j + \beta_4 JV_{ji} + \beta_5 DJV_{ji} + \beta_6 SALES_{ji} + \beta_7 CEMENT_{my} + \beta_8 EMP_{my} + \beta_9 \frac{1}{N_j} + \epsilon_{ji}$$

The results of estimating equation (10) are summarized in Table 2 under model 1. The very high $\bar{R}^2$ of .974 is attributable to the inclusion of the engineer's estimate, EE_j. Since most of the variability among bids is due to the scale or size of the project and since EE_j captures this variability, then most of the model's explanatory power is attributable to the inclusion of EE_j. In fact, since the engineer's estimate is generated by PBTB in much the same way as a bid is prepared, EE_j behaves as though it is a bid.

The variable EMP turns out to provide almost no explanatory power at all. This is probably due to the fact that the emloyment conditions in the San Francisco

Table 2

Regression Results
(N=458 bids)

Variables

Model	Constant	EE	CAP	L	1/N	N	JV	DJV	SALES	CEMENT	EMP	F-Stat	$\bar{R}^2$
1	2148K (1.24)	1.13 (82.80)	.611 (2.62)	-43.2K (-3.29)	3280K (2.46)		-193.7K (-1.95)	147.6K (1.13)	-236.9 (-1.05)	-17.0K (-1.69)	-21.0K (-.68)	2126.	.974
2	1018K (1.92)	1.13 (83.60)	.657 (2.87)	-43.6K (-3.40)	3266K (2.46)		-187.5K (-1.90)	178.9K (1.40)		-21.7K (-2.71)		2429.	.974
3	1347K (2.84)	1.13 (84.40)	.644 (2.81)	-50.2K (-4.21)	3232K (2.44)		-163.3K (-1.68)			-22.5 (-2.81)		2828.	.974
4	1306K (2.75)	1.13 (84.41)	.595 (2.56)	-47.2K (-3.88)	3157K (2.38)		-164.3K (-1.69)		-274.4 (-1.23)	-21.7 (-2.71)		2427	.974
5	2138 (3.47)	1.14 (84.67)	.612 (2.62)	-43.8K (-3.40)		-81.8K (-2.03)	-190.9K (-1.92)	153.0 (1.18)	-248.4 (-1.10)	-21.0 (-2.58)		2118	.974

K denotes thousands

$\bar{R}^2$: adjusted R^2

t-statistics are in parenthesis

Legend:

EE	Engineer's estimate
CAP	Ratio of outstanding BART work to the average sales during the the last three years
L	Project duration (in months)
N	Number of bidders
JV	Number of firms in the joint venture
DJV	Number of firms in the joint venture if EE<$5M, zero otherwise
SALES	Average sales during last three years
CEMENT	Quantity of Portland Cement shipped to Pacific states in the bid month
EMP	Number of construction workers employed during the bid month

9

Table 2 (cont.)

Summary Statistics

a. Correlation Coefficients:

Variables	1/N	L	CAP	EE	JV	CEMENT	SALES	DJV	EMP	BID
1/N	1.000									
L	-0.014	1.000								
CAP	-0.002	0.055	1.000							
EE	0.157	0.745	0.058	1.000						
JV	0.128	0.460	0.140	0.503	1.000					
CEMENT	0.235	-0.047	0.028	-0.063	-0.064	1.000				
SALES	-0.038	0.262	-0.150	0.167	0.080	0.051	1.000			
DJV	-0.034	-0.570	-0.050	-0.493	-0.166	-0.037	-0.263	1.000		
EMP	0.232	-0.097	-0.003	-0.013	-0.132	0.621	0.004	-0.085	1.000	
BID	0.174	0.708	0.075	0.986	0.484	-0.078	0.143	-0.466	-0.021	1.000

b. Means and Standard Errors:

Means	.1681	26.27	.120	6.86M	1.59	45.33	188M	.73	60.9	7.126M
Standard Errors	.0598	9.62	.326	8.84M	.90	9.60	350M	.72	3.2	9.756M

Bay Area were already taken into account by PBTB in their preparation of the engineer's estimate. In addition, this variable showed so little variation, that it was dropped from subsequent models.

The coefficient on CAP in all the models is positive and statistically different from zero. This finding is consistent with proposition 1 for increasing marginal costs. Or, as the percentage of the joint venture's total outstanding BART work rises, then subsequent bids are raised. Another interesting point is the degree of stability displayed by the coefficient of CAP across different model specifications in Table 2.

The SALES variable was included to examine the effects on size of the joint venture and bid price. The inverse empirical relationship suggests economies of scale; the larger the average size of the joint venture (weighted by using sum of the number of firms in the joint venture) the lower the bid price. However, this relationship is not statistically strong as indicated by the low t-statistic on SALES. In fact, SALES is probably closely related to the syndication process and future research should explore the syndication process incorporating bonding limits, specialization, and risk sharing. Out of such an analysis should emerge the effects of joint venture size, SALES, and bidding behavior.

One of the more puzzling results concerns CEMENT. This variable was originally intended as a proxy for industrial activity. We reasoned that as Portland Cement shipments to the western portion of the country increased, the entire construction industry level of activity rises, skilled labor became scarce, marginally competent workers were hired requiring additional supervision, thus driving up costs and the bid price. Thus, bid price and CEMENT should be positively related. However, the regression in Table 2 indicate a strong negative relationship. Confronted with the evidence, CEMENT appears not be be acting as a proxy for industry activity, but rather as a proxy for cement prices. As cement shipments to distributors (and hence supply) rise, (holding demand constant) prices should fall and hence contract cost and bid prices fall. We had originally assumed that CEMENT would capture the demand for construction effects but demand appears to have been relatively fixed over the BART period (which is consistent with the lack of variation in EMP) and thus fluctuations in CEMENT are reflected in cement prices.

As for the length of the contract, L_j, we see that its coefficient is uniformly negative and statistically significant across all specifications of the model. This result is therefore in agreement with proposition 3 that, *ceteris paribus*, the longer the contract the lower the bid submitted.

Regarding the impact of the syndication process, or the formation of joint ventures, on the bids submitted, we find that there appears to be a negative relationship between the amount bid and the number of firms comprising the joint venture. As indicated by proposition 5, one would expect that syndication should yield such benefits as risk sharing, task specialization, relaxation of bonding constraints,etc. In turn, these benefits ought to lead in the presence of competition to lower bids submitted. Our results more or less conform to this interpretation. However, the coefficient on DJV shows that relative gains derived from syndication vary directly with the size of the contract itself. Apparently, this means that on smaller contracts (i.e., contracts less than \$5M), the gains from syndication are very nearly offset by the control and coordination costs incurred in administrating the contract.

Finally, we are able to assess the effect of competition on the bids submitted by examining the sign of the coefficient for 1/N. In all specifications where 1/N is used, we find that its coefficient is positive and significant. By implication, then, an increase in N lowers bid prices. This result is in accord with our proposition 6. Since, there is no *a priori* reason why 1/N whould be used, we tried an alternative specification with N replacing 1/N. While the resulting coefficient was negative as expected, the overall explanatory power of the model was reduced slightly.

6. Summary

As stated at the outset of this study, our goal was to develop an analytical model of contractor bidding behavior, and to use the BART data base to test several propositions that were derived. Our results showed that of the six propositions set forth, none could be rejected. We may summarize these findings as follows:

1. As the joint venture's outstanding BART work increases, subsequent bids are raised.

This finding is consistent with proposition 1. Even though a complete record of each bidders existing work is not available, bidder's with more in-process BART work bid higher than those with less in-process BART work which suggests an upward sloping average cost curve.

2. Ceteris paribus, larger construction firms (including joint ventures) tend to submit lower bids than smaller firms or joint ventures.

This result appears to be consistent with both proposition 2 and proposition 5. In this case where the bidder is a single firm, this phenomenon may stem from certain economies of scale due to vertical integration of skills within the firm. Where joint ventures are involved, the syndicate's size is directly related JV, the number of firms comprising the venture. It is certainly plausible that a primary reason for forming joint ventures is to pool contractor specializations, and thereby achieve similar advantages enjoyed by the large, vertically integrated firm.

3. Holding project size and complexity constant, the longer a contractor has to complete the project, the lower his bid.

This finding is consistent with proposition 3. On the longer contracts, there were greater opportunities for cost reductions, which were shared between the contractor and the District. Furthermore, longer contracts provided more chances to share certain fixed costs (start-up costs or transaction costs). Had BART not provided the contractor with a high progress payment rate, then this finding may have been reversed to the extent the contractor had his capital tied up in the project.

4. The greater the number of firms in the joint venture submitting the bid, ceteris paribus, the lower the bid price.

The syndication process in the construction industry is not well understood. For example, what are the contractual and economic differences between syndication versus sub-contracting and why does one of these forms predominate in specific contexts? However, we can hypothesize that prior to bidding, firms choose the optimum size of the syndicate. We assume that the syndicate will admit a new member if for all members in the syndicate the benefits (risk and bond sharing and an increased chance of winning by submitting a lower bid due to a cost savings unique to the new member) outweighs the costs (the additional control and coordination costs). This analysis suggests then that joint venture size is inversely related to bid. Moreover, this relationship should be stronger on larger contracts where there is more opportunities for the syndication process to produce benefits.

5. Bid prices are reduced as the number of bidders on the project is increased.

This finding supports proposition 6. Due to the information available to the bidders prior to bid submission, each bidder was assumed to have formed an unbiased estimate of not only the number but also the identities of his competition. As the extent of the bidder's competition rises, (i.e., there is an increase in the number of bidders) he revises his chances of winning (the hazard rate) and he tends to lower his bid such that at the margin, the decreased chance of winning due to an increase in competition is offset by an increased chance of winning by shaving his bid. However, this analysis ignores the more basic question of what factors cause six contractors to bid on one project and only three on another contract?

Appendix A

As we discussed earlier, it was not possible to obtain detailed information concerning the work load of each joint venture at the time a bid was submitted on a particular BART contract. Thus, it was necessary to construct some proxy, or crude capacity measure, for each of the joint ventures submitting bids on the BART projects. Our solution to the problem was to use the following disaggregation-aggregation procedure:

(1) Identify all those BART projects that are still under construction at the time BID_{ji} is submitted and that involves A or B or X.

(2) Estimate the dollar amount of work awaiting completion on the relevant projects in (1). For example, the dollar amount is,

$$\left[\frac{CDATE_k - BDATE_j}{CDATE_k - BDATE_k}\right] \times \text{Actual cost of } k.$$

If project k costing \$2M which involves firm A took 20 months ($CDATE_k$-$BDATE_j$) to complete and at the time of the bid on j there were 4 months left till completion ($CDATE_k$-$BDATE_j$) then the dollar amount is 4/20 × \$2M = \$400K.

(3) If the BART projects under construction involve joint ventures, then allocate the dollar amount in (2) using "sum of the number of firms in the joint venture" to the firm which is common to both the existing project and the currently bid project. For example, firm A is in a joint venture involving C as the number 2 firm. Instead of allocating the \$400K from (2) equally to C and A we choose a method of allocation which weights the amount allocated to the order of the firms in the joint venture. Using sum of the number of firms in the joint venture yields A's share: $\frac{1}{1+2} = \frac{1}{3}$. If A were the lead firm, its share would have been 2/3. Thus, A in the joint venture C-A would receive 1/3 × \$400K or \$133K.

Since we did not have data regarding the sharing rules of the members in a joint venture, we chose this method as the most reasonable, a priori. Step (3) is thus a disaggregation of the outstanding projects into specific firms.

(4) Sum over all the outstanding jobs, the weighted (by step (3)) dollar amount of work to complete (calculated in (2)) involving all the firms in the joint venture submitting BID_{ji}. For example, if on the existing project signed by X-Y-Z there was 1/2 of the job to complete, X's share would be,

$$\left[\frac{3}{1+2+3}\right] \frac{1}{2} (\$1M) = \$250K.$$

And if B is not working on any projects, then the sum in step (4) is: X's work + A's work = A-B-X's work
$133K + $250K = $383K.

(5) Finally, scale (4) by the relative size of the joint venture. $383K of outstanding work is more important to a joint venture composed of three $1 million in sales firms than is $383K of work to three $100 million firms. The scaling procedure involved the current sales figures ($SALES_{iy}$) for each of the firms in the joint venture A-B-X. Thus,

$$CAP_{ji} = \frac{\$383K}{SALES_{iy}}, \text{ and}$$

$$SALES_{iy} = 3/6\ SALES_{ay} + 2/6\ SALES_{by} + 1/6\ SALES_{xy}$$

Again, the individual firms' sales are weighted using sum of the number of firms and the amount of sales data used for each firm included the current year and the two previous years' sales data in order to "smooth out" the sales data.

Appendix B

Derivation of P1.

For increasing marginal costs, where z is the input,[1]

$$\frac{dc}{dz} > 0 \text{ and } \frac{d^2c}{dz^2} > 0$$

We seek to prove that $\frac{\partial B}{\partial y} > 0$ by differentiating (5) yielding:

$$\frac{\partial B}{\partial y} = -H^{-2}(B)\frac{\partial B}{\partial y} + E_{\tilde{x}}\frac{\partial c(\tilde{x}+y)}{\partial y} - \frac{\partial c(y)}{\partial y}$$

where $H^{-1}(B) = \frac{1-F(B)}{f(B)}$. Grouping $\frac{\partial B}{\partial y}$ produces,

$$\frac{\partial B}{\partial y}(1+H^{-2}(B)) = E_{\tilde{x}}\frac{\partial c(\tilde{x}+y)}{\partial y} - \frac{\partial c(y)}{\partial y}$$

$$(6) \qquad \frac{\partial B}{\partial y} = \left[1 + \frac{1}{H^2(B)}\right]^{-1}\left[E_{\tilde{x}}c'(\tilde{x}+y) - c'(y)\right]$$

where c' denotes the first derivative. By assumption, the second term on right is positive. Hence the proposition follows.

Derivation of P2

The same procedure as followed in Proposition 1 yields the following relation:

$$\frac{\partial B}{\partial S} = \frac{E_{\tilde{x}}\frac{\partial c(\tilde{x}+y)}{\partial S} - \frac{\partial c(y)}{\partial S}}{1 + H^{-2}(B)}$$

By assumption, the numerator is negative and therefore, $\frac{\partial B}{\partial S} < 0$.

Propositions P3, P4, and P5 are derived in essentially the same manner as Proposition 2.

[1]These results can be extended easily for the case where z is a vector of inputs.

Derivation of P6

F(B) denotes the bidder's estimate of the probability that its bid of B will exceed at least one other bid and hence loose the contract. 1-F(B) is then the probability of winning the contract with a low bid of B. If this bidder faces n identical and independent competitors each of which is perceived to possess identical density functions, g(b) where $G(B) = \int_{-\infty}^{B} g(b)db$ is the probability that one of the identical competitors submits a lower bid than B. Then,

$$1-F(B) = [1-G(B)]^n \text{ and,}$$

$$f(B) = n(1-G(B))^{n-1}\, g(B).$$

Substituting into (5) yields:

$$B = \frac{1}{n}\left[\frac{1-G(B)}{g(B)}\right] + E_{\tilde{x}}\, c(\tilde{x}+y) - c(y)$$

Differentiating this expression with respect to n produces,

$$\frac{\partial B}{\partial n} = \frac{-\frac{H(B)}{n^2}}{1 - \frac{1}{n}\frac{\partial H(B)}{\partial B}}$$

where

$$H(B) \equiv \frac{1-G(B)}{g(B)}$$

Since H(B) > 0 and the hazard rate is decreasing in $B\left(\frac{\partial H(B)}{\partial B} < 0\right)$, the numerator is negative and the denominator positive; $\frac{\partial B}{\partial n} < 0$.

FACILITIES

B U S   S C H E D U L E

WEDNESDAY, 17 November 1976

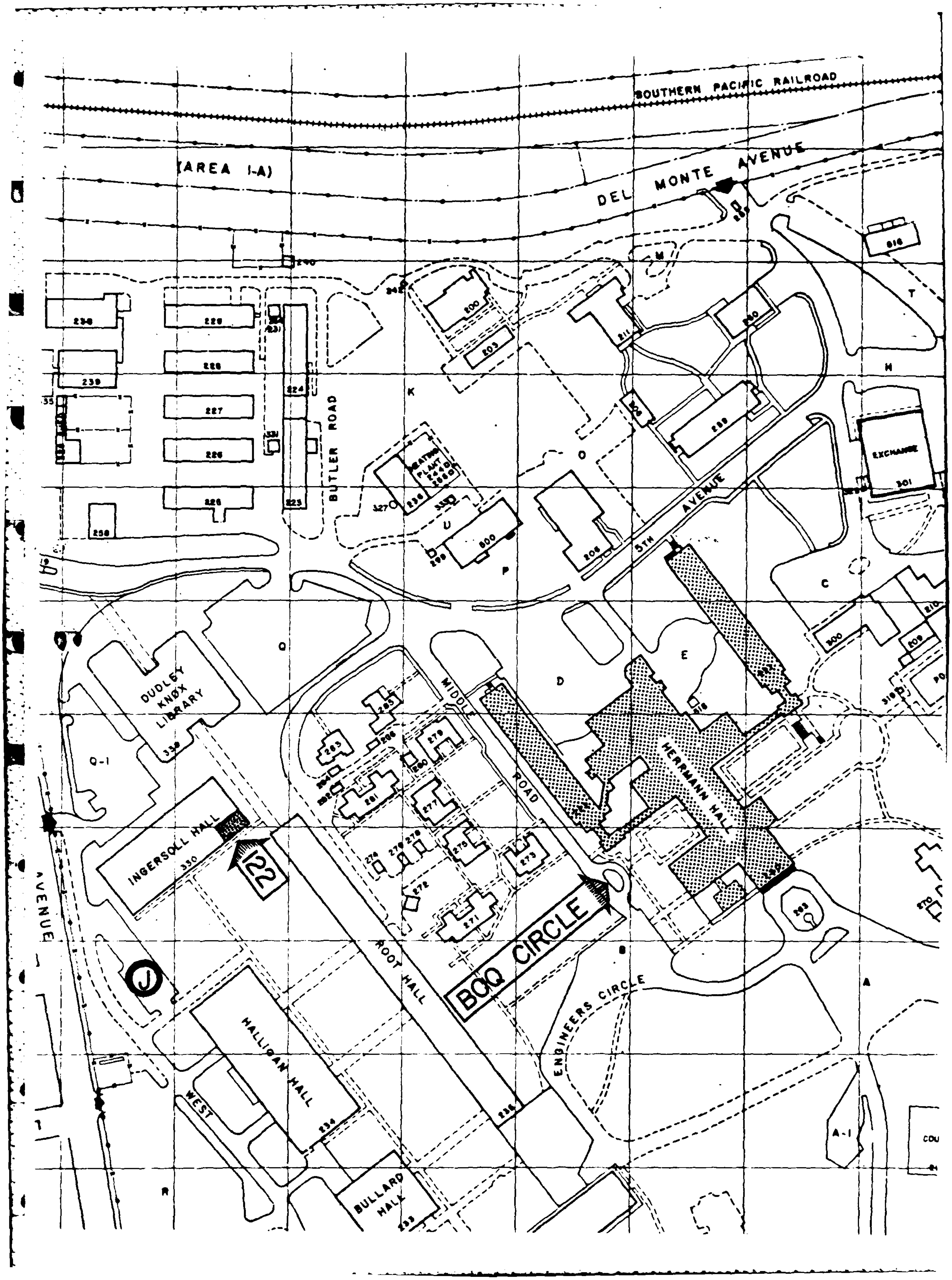
8:00	a.m.	Hilton Inn Resort (Royal Inn) to Ingersoll Hall (Lot J)
8:15	a.m.	Same
8:30	a.m.	Same
8:45	a.m.	Same
5:00	p.m.	Ingersoll Hall to Hilton Inn Resort
5:15	p.m.	Same
6:30	p.m.	BOQ Circle to Hilton Inn Resort

THURSDAY, 18 November 1976

8:00	a.m.	Hilton Inn Resort to Ingersoll Hall
8:15	a.m.	Same
5:00	p.m.	Ingersoll Hall to Hilton Inn Resort
5:15	p.m.	Same
5:20	p.m.	Hilton Inn Resort to BOQ Circle
6:25	p.m.	Same
7:00	p.m.	Same
9:30	p.m.	BOQ Circle to Hilton Inn Resort
9:45	p.m.	Same
10:00	p.m.	Same

FRIDAY, 19 November 1976

8:00	a.m.	Hilton Inn Resort to Ingersoll Hall
8:15	a.m.	Same
12:00	p.m.	Ingersoll Hall to Hilton Inn Resort to Airport
12:30	p.m.	Ingersoll Hall To Hilton Inn Resort



SOUTHERN PACIFIC RAILROAD
(AREA I-A)
DEL MONTE AVENUE
BUTLER ROAD
5TH AVENUE
EXCHANGE
301
DUDLEY KNOX LIBRARY
339
INGERSOLL HALL
330
122
HERRMANN HALL
MIDDLE ROAD
ROOT HALL
BOQ CIRCLE
ENGINEERS CIRCLE
HALLIGAN HALL
234
BULLARD HALL
233
WEST
AVENUE
J
238
229
228
227
226
225
239
258
224
223
200
203
211
250
259
316
206
300
271
273
275
277
281
283
285
263
K
O
P
Q
Q-1
D
E
C
H
T
A
A-1
B
R
U
M

GUEST SPEAKERS

BIOGRAPHIES OF PARTICIPANTS

PAUL F. ARVIS is a Director of the Army Procurement Research Office (APRO). APRO is assigned to the Army Logistics Management Center and is under the operational control of the US Army Materiel Development and Readiness Command's Director of Procurement and Production. In this capacity, Dr. Arvis conducts and directs research studies on procurement policy and methods, provides consultation services on emerging procurement problems, and assists in the development of Army procurement policy and instructions. Dr. Arvis has been in APRO for over six years, the last three as Director. Dr. Arvis holds a bachelor's degree from Concord College and a master's degree from Marshall University. He also earned MA and Ph.D degrees from American University with major course work in R&D management and technology of management. He is a member of the American Institute of Industrial Engineers and the National Contract Management Association in which he is a Certified Professional Contracts Manager. He also serves as Adjunct Professor and Chairman of Procurement and Contract Management for the Florida Institute of Technology at the FIT Fort Lee Campus.

JOSEPH BERKE is the Chief, Procurement Programs Experimental Technology Incentives Program (ETIP) for the National Bureau of Standards. Joseph Berke's responsibilities include liaison and interaction with Federal, State, and local government agencies to design, implement and manage experiments in procurement policy. From 1959 to 1973 Mr. Berke was employed by the Stanford Research Institute, Menlo Park, California. He rose from physicist to project director of programs in the transfer of technology in the areas of transportation, forensic sciences and the US Postal Service. He holds both BS and MS degrees in physics from California State University.

PETER C. BOULAY is Director of the Market Research and Marketing Division of GSA's Federal Supply Service. The division conducts customer surveys, derives business forecasts, publishes catalogs, brochures and newsletters, and generally performs the standard marketing functions of a major, diverse business corporation. Mr. Boulay's bachelor's degree is in literature and he has done extensive graduate work in clinical psychology. He has been a teacher, magazine editor and president of an audio-visual corporation.

RONALD L. BULMER, LtCol, USAF is currently assigned Chief, Systems Branch, Systems Procurement Division, Directorate of Procurement Policy, Deputy Chief of Staff/ Systems and Logistics, HQ, USAF. The Systems Procurement Branch reviews all major weapon system acquisitions for the Air Force, participates in Business Strategy and Procurement Evaluation Panel meetings, assists in Foreign Military Sales procurements and is responsible for the establishment of procurement policy relating to weapon system acquisition. He served as Secretary for Air Force Secretarial Award Fee Boards on major weapon system Award Fee Boards chaired by the Assistant Secretary of the Air Force, Installations and Logistics. Similar weapons system acquisition experience in HQ Air Force Systems Command working with the F-15, F-111 and A-10 programs. Director of Procurement 313th Air Division, Okinawa, managed two procurement offices at Kadena and Naha Air Force Bases. Commenced working in the field of procurement upon graduation in 1965 from the Industrial Planning and Procurement, Education with Industry, General Dynamics/ Astronautics/San Diego.

FRED B. BUNKE is presently Assistant Commissioner for Procurement, Federal Supply Service, General Services Administration. From 1950 - 1960, Mr. Bunke held various supply and procurement billets at sea and ashore as a Navy Supply Corps Officer. From 1960 - 1963, he served as the Assistant Director, Tools Division, Procurement Directorate Defense General Supply Center, Richmond, Virginia. In 1963 he joined the Federal Supply Service and held various procurement management positions in the Office of Procurement, prior to becoming Assistant Commissioner for Procurement in 1974. Mr. Bunke attended the Princeton and George Washington Universities and received his BS in Business Administration from American University (1949). He is also a graduate of the Industrial College of the Armed Forces (1972).

ALFRED M FEILER is currently Program Manager of Project TRANSIM at the University of California, Los Angeles. He is the originator of TRANSIM and the Project Risk Management technique. His technical specialty field is the development and application of cumputer-based management tools for the solution of complex problems of business and institutions. He received his BS and MS degrees from Carnegie Tech in 1941 and 1942, respectively, and has since accumulated over thirty years of experience in the fields of management, engineering and research. Mr. Feiler has specialized in the systems approach to solving project management, logistics, distribution and system problems over the full range from software to hardware. Prior to his present position, he was Vice President of Pneumodynamics Corporation Western Region and Division Manager of Pneumodynamic Advanced Systems Development Division, El Segundo, California. During this time, Mr. Feiler successfully utilized the systems approach to develop semi-automatic FAST missile and cargo handling systems for the US Navy combatant and supply ships. Prior to this, he was Chief of Advanced Systems Research Aircraft Division, Hughes Tool Company where he was primarily concerned with systems analysis of logistics and transportation problems. Mr. Feiler has authored numerous reports and papers on simulation, project risk management and logistics and transportation systems analysis, and has served on several government committees and advisory boards in connection with his specialty fields of interest.

THEODORE J. FODY was employed by the Western Electric Co. from September 1956 thru April 1969. His experience during this period was centered in the Purchasing Department where he reached the level of Buyers and purchased a variety of products. In May 1969, he was employed by the Southern Railway Company as Senior Buyer and was eventually promoted to General Purchasing Agent. In August 1974, Mr. Fody left Southern Railway and became Chief of the Procurement Policy Area of the Experimental Technology Incentives Program at the National Bureau of Standards. On 1 November 1975 Mr. Fody was appointed Director of the Experimental Technology Division at Feder Supply Service and he currently holds that position.

FRANZ A.P. FRISCH graduated from the Techn. University of Vienna, Austria. He has close to 30 years experience in shipbuilding and related subjects. He worked as Naval-Architect, Guarantee-Engineer, Chief Estimator, Production Manager, and Director for Shipyard-Planning and Maintenance in Austria, Denmark, Sweden, and Germany. In 1956 he was first invited to the U.S.A. to testify on foreign cost and production in subsidy cases before the Maritime Administration. From 1957 thru 1962 he was associated with several US Naval Architect firms. He was owners representative in Europe and Japan; he conducted studies on transport economy for Venezuela, ICC, and shipowners; he was consultant for shipyard planning in Brazil and Europe. In 1963 he joined the staff of CNA (Center for Naval Analysis) and became head of the logistic section and study director; there he originated the FDL ship and ship concept, and was assigned as advisor to the project manager. From 1968 through 1974 Dr. Frisch was faculty member and visiting lecturer at the M.I.T. (Massachusetts Institute of Technology); he lectured on shipyard management, ocean transportation, systems theory in transportation, and in interdisciplinary seminars. In 1972 and 1973 he was consultant to the Dubai Drydock LTD for layout of a new shipyard in the Arabian Gulf. Since November 1973 Dr. Frisch has been with the NAVSEA's ship production office, mostly involved in special projects.

RICHARD J. HAMPTON Capt, USAF is presently a Procurement Management Staff Officer with the Headquarters, Defense Supply Agency. Prior to joining DSA, he was assigned to the Air Force Institute of Technology from September 1972 thru December 1973 to obtain an MBA in Procurement and Contracting from the George Washington University. From June 1969 to August 1972, he served as the Base Procurement Officer at Eielson AFB, Alaska. From July 1967 to June 1969, he was assigned as a contract negotiator with the Air Force Logistics Command. Captain Hampton holds a BS in Business from the University of Minnesota (1967) and a MBA in Procurement and Contracting from the George Washington University (1974), and is presently pursuing a DBA at the George Washington University.

LEROY J. HAUGH is the Assistant Administrator for Regulations in the Office of Federal Procurement Policy (OFPP), Office of Management and Budget. Mr. Haugh began civilian employment with the Navy in 1954 as a Management Intern in the Bureau of Ships, where he spent six years as a Contract Specialist. He joined the staff of the Assistant Secretary of the Navy (I&L) in 1960 as a Staff Assistant for Procurement, and was appointed Navy Policy Member of the ASPR Committee in 1961. In 1969 he became Deputy Director of Procurement as Vice Chairman of the Regulations Study Group. He then moved to the Office of the Assistant Secretary of Defense (I&L), where he was Director of Contract Placement and Finance until joining OFPP in May 1975. Mr. Haugh holds a BA in Political Science from the College of St. Thomas, a JD from Georgetown University, and an MSBA from George Washington University. He is also a graduate of the Industrial College of the Armed Forces.

CHARLES HULICK is a Procurement Program Analyst for the Experimental Technology Incentive Program (ETIP), National Bureau of Standards. Charles Hulick is involved in the designing and implementing of experiments using procurement incentives with other Federal agencies. Prior to joining the ETIP staff, he was the contracting officer for several of the original ETIP experiments at the Federal Supply Service, General Services Administration (GSA). His MBA is from the American University in Washington, D.C. and his BS in economics is from the Wharton School, University of Pennsylvania.

ROBERT R. JUDSON attended the University of Illinois at Champaign-Urbana, where he majored in government and minored in history. He received the degree of Bachelor of Arts in June of 1951. Graduate study followed at the University of Illinois where he received the degree of Master of Science in June 1955. His research in the field of international relations was under the direction of Professor Alfred E. Bestor. The Doctor of Philosophy program in International Relations was pursued at American University in Washington, D.C., with course work completed in June 1966. Since 1955 he has been working in the field of Federal Procurement and has had assignments which included US Navy, Bureau of Ships, Negotiator, 1955-60; Collins Radio Company, Manager, Corporate Contract Administration, 1960-66; IBM, Federal Systems Division, Manager, Contracts Policy and Planning, 1966-70; Commission on Government Procurement, Deputy Director, 1970-73. In September 1973 he joined the faculty of the Naval Postgraduate School, Monterey, California, where he is teaching in the Department of Operations Research and Administrative Sciences. In addition, he is a consultant to the Subcommittee on Federal Procurement of the Senate Government Operations Committee. He is a member of the National Contract Management Association and Phi Eta Sigma.

JOHN H. KUNSEMILLER was designated Director, Contract Administration and Support, OASD (I&L), effective 14 November 1975. Mr. Kunsemiller entered procurement as a trainee in the Air Materiel Command, Wright-Patterson AFB in 1952. He rapidly progressed to the position of Supervisory Contracting Officer. From 1958 to 1965, he was procurement supervisor on major R&D space programs at the AF Space Systems Division (now SAMSO). In 1965 he was promoted to a Procurement Staff Supervisory position in the Air Force Systems Command, Andrews AFB. From 1967 to May 1973, he held the position of Chief, Defense Procurement Management Review Program, HQ, USAF, where he was responsible for the assessment of Air Force procurement management efficiency and effectiveness, worldwide. During 1971 he also served as a member of the Commission on Government Procurement (Study Group 12) which was concerned with major systems acquisition. In June 1973, he moved to the position of Assiciate Director, Directorate for Procurement Policy, Headquarters, US Air Force and was also named by the President as the Air Force representative on the President's Committee for the Purchase of Blind and Severely Handicapped Products. He has a BS degree from the University of Dayton and an MBA degree from the University of Southern California.

MORDECAI Z. LABOVITZ an honors graduate from Allegheny College, has in his ten plus years with the Government, devoted the greater share of his time to major systems acquisition in both civilian and military agencies. His experience has been in both line and staff capacities. He has been a negotiator and contracting officer in the Naval Systems Commands, a negotiator with the US Postal Service, and during the period from May - November 1974, while on loan from the Navy, a staff member with the US Senate Subcommittee on Federal Spending Practices. Since March 1975, he has been on the staff of the Deputy Assistant Secretary of Defense (Procurement) working in the Directorate for Weapon System Procurement on, among other things, the implementation of the Commission on Government Procurement Recommendations C1-C12 and ultimately, OMB Circular A-109. Mr. Labovitz is a member of Pi Gamma Mu (National Social Science Honor Society) and a certified Professional Contracts Manager.

MATTHIAS LASKER was born in 1926 and attended public schools in Boston. He served in the US Army from 1943 to 1946. He has an A.B. from the University of Massachusetts and an M.A. from the University of Michigan. Mr. Lasker's career with the Federal Government has included service with the Department of State at the American Embassy in Tokyo, as Contracting Officer with the Air Force, and as Director of the Contract Management Office of NASA's Goddard Space Flight Center. He is presently Director of the Division of Grants Policy and Regulations Development in the Office of Grants and Procurement Management in the Department of Health, Education, and Welfare. In this position he formulates the Department's policies for the administration of grants and chairs the Department's Executive Committee on Grants Administration Policy.

ROBERT G. LAUCK is a legislative attorney in the American Law Division of Congressional Research Service (CRS) of the US Congress. He received the AB degree in 1949 from Wichita State University, the JD degree in 1954 from Kansas University and the LL.M. degree in 1960 from George Washington University. He is admitted to practice in Kansas and Minnesota and is a member of the Supreme Court Bar. After graduation from law school, he joined the Navy's Office of General Counsel. Next, he served with the Army Judge Advocate General's Office in Heidleberg, and Paris, doing public contract trial work, teaching and research in procurement law. In 1960, he joined Sperry Rand as counsel to the Univac Division in St. Paul and spenta total of nearly eight years with industry, including service more recently as counsel to the Washington corporate office of General Electric. Between Univac and GE, Bob was a member of the faculty of William Mitchell College of law in St. Paul where he started the first course in public contract law designed for law students in that part of the country, a course still offered at Mitchell. Bob was an Assistant General Counsel with the Procurement Commission and joined CRS after the Commission made its report in December 1972. With CRS, he has served as Senior Counsel to the Senate Ad Hoc Special Committee on Secret and Confidential Documents.

WILLIAM R. LEAK graduated from San Jose State College in 1959 with a BA in Physics. He first worked at Ames Research Laboratory, NASA, Moffett Field, California. There he participated in the development of Light Gas Guns from an initial muzzle velocity of 8,000 feet per second to above 30,000 feet per second. He also initiated his studies into the nature of Radiation Heat Transfer from the nose of hypervelocity projectiles. He contributed original data for the design of heat shields for vehicles re-entering from a space orbit. He subsequently designed and tested Explosively-driven Hypervelocity Guns for Physics International Corp., San Leandro California. In 1967 he set a world record for free-flight projectiles of 42,500 feet per second that has not been superseded. Presently he is a Quality Assurance Engineer for the Defense Contract Administration Services Management Area, Van Nuys, California. For the last two years he has spent approximately half of his work-time on the Quality Assurance Of Computer Softwear, on large systems entailing $10 - 80 million dollars of software per contract.

LYLE W. LOCKWOOD Major, (M.S. Logistics Management - Procurement Major, Air Force Institute of Technology) is Deputy Director, Air Force Business Research Management Center. He received his commission through ROTC upon graduation from Purdue University. His first Air Force assignment was as a production officer in the Air Force Plant Representative's Office at Lockheed Missiles and Space Company, Sunnyvale, California. He served as a quality control officer in the Air Force Plant Representative's Office at Detroit Diesel-Allison Division, GMC, Indianapolis, Indiana. Major Lockwood also served as Chief, Quality Assurance Branch, Deputy for F-15/JEPO, Aeronautical Systems Division, Wright-Patterson, AFB, Ohio. He has completed the Education-With-Industry program at The Boeing Company, Seattle, Washington, and Air Force Squadron Officers School. He is currently chairman of the Dayton Ohio Section, American Society for Quality Control. His awards include the Air Force Commendation Medal and the Air Force Meritorious Service Medal.

RICHARD LORETTE is a member and Fellow of NCMA and a member of the Society of Logistics Engineers; he has held management positions in the Air Force Systems Command (Weapons Acquisition; B-52 SPO and C/KC-135 SPO) and Air Force Institute of Technology prior to his retirement from the Air Force in 1973. Dr. Lorette has taught courses in Procurement and in Program Management and published several articles in the general area of procurement and Systems Acquisition. He recently completed a one-year assignment to the Far East where he taught Systems Management courses to military personnel and assisted in the establishment of the SOLE chapter in Seoul, Korea. He is a 1950 graduate of West Point, has an MBA in Engineering Administration (AFIT), a Doctorate in Business Administration from the Harvard University Graduate School of Business Administration and is an Associate Professor in the Systems Group, Systems Management Center, University of Southern California.

W. GREGOR MACFARLAN is President of Sterling Institute (DAC). Over the last sixteen years, his experience has traversed virtually the entire spectrum of the Federal procurement, logistic support, and program management functions. His association with the fields of education and training spans two decades. Currently, Mr. Macfarlan directs the curricula design, development, and conduct of courses to procurement and non-procurement personnel throughout the Federal Government and in the private sector, as well as the provision of research and consulting services concerned with implementing Federal procurement regulations and policy. Previously, he served on the faculty of Boston University, where he participated in structuring an integrated curriculum of studies for the College of General Education; and as Chairman of the Department of Social Sciences, Westbrook College, Portland, Maine. Mr. Macfarlan received a Bachelor of Arts degree from the University of Maine. Under a university scholarship, he received a Master of Arts degree in international public administration from the same institution. While on the faculty of Boston University during 1959-61, he attended graduate school at Harvard University (political science) and Boston University (international law). He also has pursued graduate studies in economics at the University of Virginia.

MARTIN D. MARTIN LtCol, USAF, was born in Franklin, Louisiana in 1935. He received his Bachelor of Science degree and his Air Force commission as a distinguished military ROTC graduate from the Louisiana State University in 1958. His two graduate degrees, an M.B.A. and Ph.D., are both from the University of Oklahoma, and were received in 1966 and 1971, respectively. His fields of graduate study include Management and Systems Management Theory. Lieutenant Colonel Martin is currently assigned to the Air Force Institute of Technology as an Associate Professor of Logistics Management. He has served as a faculty member for the University of Southern California, Wittenberg University, and Wright State University. Prior to his military tour he was employed by Shell Oil Company.

ANDREW B. McCONNELL is an Associate Director in the General Procurement Subdivision, Procurement and Systems Acquisition Division. From July 1969 until February 1975, he served as an Assistant Director for Major Acquisitions Subdivision, Procurement and Systems Acquisition Division. Mr. McConnell served in the US Navy from 1943 to 1946. After receiving a Bachelor of Science degree from the University of Southern California in 1950 he went to work in public accounting. He was employed by Meyer Pritkin and Company and Alexander Grant and Company in Comptroller of Imperialle Fuels Ltd., in London, Ontario, Canada, a wholesale and retail fuel distribution firm. Since joining GAO in 1957, Mr. McConnell has had a wide variety of responsibilities having served in the Defense Division, for Far East Branch, Tokyo, Japan, and the Procurement and Systems Acquisition Division. Mr. McConnell is a CPA (California) and a Chartered Accountant (Ontario, Canada). He is a member of the California Society of Certified Public Accountants, the American Institute of Certified Public Accountants, the Institute of Chartered Accountants of Ontario, and the Canadian Institute of Chartered Accountants.

JAMES B. McNALLEN is a Marketing Research Specialist in the Market Research and Marketing Division of the Federal Supply Service's Office of Customer Service and Support. He has a BA degree from Columbia and MBA and PH.D. degrees from New York's University's Graduate School of Business Administration. His experience outside of civil service includes teaching and executive and administrative positions in the oil industry. He recently was selected for Captain in the US Naval Reserve and currently serves as Commanding Officer of a Reserve Unit in the Washington, DC area.

MARTIN A. METH is a staff engineer with the Assistant Secretary of Defense (I&L), Directorate for Acquisition and Support Planning. This directorate serves as the policy and analysis office for the Deputy Assistant Secretary of Defense (Materiel Acquisition) - Mr. Jacques S. Gansler. Mr. Meth is primarily responsible for recommending weapon system design tradeoff approaches as they relate to improving operational effectiveness and reducing O&S costs. Also, he provides independent estimates of reliability, maintainability and logistic plans of major weapon system programs and other materiel acquisition. Mr. Meth is the Chairman of the OSD/Tri-Service Warranty Study Group. Prior to joining OSD, Mr. Meth was Naval Air System Command assistant project manager for logistics for Reconnaissance, Electronic Warfare and Special Intelligence equipment. His responsibilities included logistic planning, logistic support acquisition and maintenance engineering. In NAVAIR, Mr. Meth, also has held the position of project engineer for automatic flight control systems. Mr. Meth received his Bachelor of Electronic Engineering in 1963 from the City College of New York and LLB from George Washington University in 1967.

CHARLES H. PIERSALL, JR CDR, is the Head of Project Management Policy and Deputy Director for Systems Acquisition at the Headquarters, Naval Material Command. He is a graduate of the New York State Maritime College and has advanced degrees in Mechanical engineering and Business from the Naval Postgraduate School and University of Rochester, respectively. CDR Piersall is an Engineering Duty Officer who has had numerous tours in shipbuilding and ship maintenance in industrial activieies. He was a Shipbuilding Consultant for the CNO while stationed at the Center for Naval Analyses (CNA). Prior to his current assignment he was Director of Production, T&E and Integrated Logistic Support, LHA Project in the Naval Sea Systems Command. He holds the Meritorious Service Medal from that assignment. CDR Piersall is a full member of the Society of Sigma Xi, having been promoted based on contributions to Shipbuilding/Ship maintenance research while on CNA. He is the Assistant Secretary-Treasurer of the American Society of Naval Engineers.

CHARLES W. (SKIP) RYLAND CDR, Supply Corps, United States Navy is presently the Head, Acquisition Programs Branch of the Systems Acquisition Division at the Headquarters, Naval Material Command. CDR Ryland received an Undergraduate Degree in Accounting from the University of Southern Mississippi and a MBA degree in Procurement and Contracting from the George Washington University. His previous duty assignments have included USS SAN JOAQUIN COUNTY (LST 1122); Marine Corps Air Station Cherry Point, N.C.; USS POLLUX (AKS 4); Naval Supply Depot, Yokosuka, Japan; Staff, Commander Naval Air Forces Atlantic; and Naval Regional Procurement Office, Washington, DC

Background Sheet for CDR Arthur C. Meiners, Jr. (SC) USN

Educational Background

1956	B.S.B.A.	Rockhurst College, Kansas City, MO
1964	M.B.A.	Graduate School of Business Administration University of Michigan
1973	D.B.A	The George Washington University (Dissertation - Control of Major Changes and Resultant Cost Growth in Weapon System Acquisition Contracts)

Present/Past Duty Stations (Relating to Acquisition)

1973 - Present		Business/Financial Manager, Large Amphibious Assault Ship Project (LHA)
1969 - 1970		Director of Purchase Operations Division, Naval Supply Systems Command
1964 - 1967		Contracting Officer, Philadelphia Naval Shipyard
1961 - 1963		Assistant Control Dept. Officer, Naval Supply Depot, Guantanamo Bay, Cuba
1959 - 1961		Assistant Hydrographic Material Officer and Data Processing Department Head, Naval Supply Depot, Philadelphia, PA
1958 - 1959		Fiscal Officer, Naval Air Station, Denver, Colo.
1957 - 1958		Supply Officer, USS EATON (DD 510)

ROBERT B. SHEARER is Vice President of Contract Management Education and Research Institute, Inc of Dayton, Ohio. He is a partner in the law firm of Shearer and Garrett. Until May 1976, he was a Professor of Government Contract Law in the Department of Procurement and Production, School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB. He holds a Juris Doctor from the College of Law, University of Kentucky, having graduated from that institution in 1952. He has also attended the Graduate Extension Center, the Ohio State University. From 1966 thru 1971, Mr. Shearer was a Trial Attorney in the office of the Air Force Chief Trial Attorney, representing the Government before the Armed Services Board of Contract Appeals. From 1961 thru 1965 Mr. Shearer served as the contracts legal advisor in the office of the Staff Judge Advocate, to the Commander, Wright-Patterson AFB. Previously, Mr. Shearer had held legal positions with the Air Material Command and Air Force Logistics Command, United States Air Force. Mr. Shearer serves as Seminar Leader at the Naval Postgraduate School, Monterey, California, lectures in the graduate School of Logistics, AFIT, and is consultant on Contract Law and administration courses with the University of Wisconsin Extension Department of Engineering.

DONALD E. SOWLE is President of Don Sowle Associates, Inc., a diversified management consulting firm specializing in the fields of procurement and logistics management, contract administration, business organization and planning, professional training, and management information systems. From June 1970 until May 1973, Mr. Sowle was the Director of Studies, the principal staff position, for the Commission on Government Procurement. He was responsible for designing, developing,organizing, staffing, directing, and controlling the most massive study of Federal procurement ever undertaken. While Director, Contract Administration Services, Office of the Secretary of Defense, Washington, DC, Mr. Sowle directed Project 60 which was one of the most far-reaching management projects in the Department of Defense. The study involved detailed analysis of how Government contracts with industry are administered by the Army, Navy, Air Force, Defense Supply Agency, and the National Aeronautics and Space Administration. The recommendations of this study were implemented nationally.

PERRY C. STEWART is Director of Concepts and Analysis in the recently activated Air Force Acquisition Logistics Division at Wright-Patterson Air Force Base, Ohio. His organization is responsible for developing and applying logistics analysis and evaluation techniques in support of Air Force system and equipment acquisition programs. One of the principal activities is the preparation and evaluation of logistics supportability contract provisions, including support cost guarantees and reliability improvement warranties.

DONALD R. TEMPLEMAN has a BA in Economics from California State University at Los Angeles, a Master of Business Economics from Claremont Graduate School at Claremont, California, and has done extensive graduate work beyond the Master's level in Business Economics at Claremont. Mr. Templeman has taught courses in Economics, Business Administration, and Industrial Psychology for both Chapman College, Orange, California, and California State University at San Bernardino. Mr. Templeman has 14 years of procurement experience beginning in 1962 as a Contract Negotiator with the Air Force Systems Command's Ballastic System Division. From 1965 until 1971 he was a Contracting Officer at the Air Force's Western Test Range and shortly before joining the Small Business Administration in 1972, he was on the staff of the University of California at Los Angeles as a Contract and Grants Officer. Since joining SBA in 1972, Mr. Templeman held two different Procurement Analyst positions and for the past 15 months has been Chief of SBA's Technology Assistance Division. SBA's Technology Assistance Division is involved in both technology transfer and providing procurement assistance to small research and development and high-technology firms.

SUSUMU UYEDA earned a BS from UCLA and Masters in Public Administration at the American University. Mr. Uyeda's career with the Federal Government include service with the US Army Audit Agency, Defense Supply Agency, the General Accounting Office, and the Office of Management and Budget. He has participated in numerous interagency studies on grant administration. He was the Chairman of the Task Force and the Principal author of OMB Circular A-102, which provided standard administrative requirements for grants to State and local governments. Recently, he transfered from the Grants Management Branch, Intergovernmental Relations and Regional Operations Division, to the Financial Management Branch, Budget Review Division, in OMB.

JOHN V. WALSH was born and raised in Cleveland, Ohio. After attending high school, served in the US Army from 1942 to 1946. In 1947 he entered the University of Dayton and graduated with a Bachelor of Arts degree in 1951. Mr. Walsh is currently employed with the Department of Defense as the Director of Procurement, Office of Scientific Research. Mr. Walsh has been associated with several sailing groups in the Chesapeake Bay area and is active in sailing events and organizing races. He organized and is a charter member of the German Shepherd Dog Club of Anne Arundel County and has been an active breeder and handler of German Shepherds for many years in the Washington area. He has a private pilot's license and is associated with several flying clubs in the Maryland area.

RALPH P. WILCOX is Manager of Support Concepts Staff, Lear Siegler, Inc., Instrument Division. He has held positions of Manager, Products Support Department, Manager of ILS and Manager, Support Logistics. In his present assignment, he is responsible to define, evaluate and recommend future support plans, and assist in the formulation of new support requirements and specifications for DOD/Military/Industry interfaces. He holds a BS degree in Aeronautical Engineering from Indiana Institute of Technology, and in 1946 he entered the field of aerospace at the Glenn L. Martin Company, Baltimore. In 1964 he was instrumental in the introduction of the Failure Free Warranty concept which resulted in the development of the first two FFW USN/LSI contracts. During the past six years, he has participated in various FFW and RIW symposium/seminars, and is presently Chairman of the CODSIA Task Group on RIW, working in conjunction with OASD and the Air Force. He is presently LSI corporate member and Vice Chairman of the AIA Product Support Committee and Western Michigan State Director, charter and senior member of the Society of Logistics Engineers.

ROBERT F. WILLIAMS is Chief of the Test and Evaluation Group of the Army Procurement Research Office, Ft. Lee, VA. He is now a Procurement Analyst but in the past has served in the positions of Operations Research Analyst (with the Army), Systems Engineer (with the Air Force) and Aeronautical Engineer (also with the Air Force). His educational background is similarly varied with a bachelor of science degree in Aeronautical Engineering from the University of Wyoming and a Master of Commerce degree in Marketing from the University of Richmond. In his work, Mr. Williams deals primarily with procurement research and has authored many publications on the subject. One of his most recent is the lead article in the Nov-Dec issue of the Army Logistician Magazine on DARCOM Procurement Management Systems (PROMS). He is no stranger to these symposia. At last year's Procurement Research Symposium, he gave two presentations. Mr. Williams is secretary of the James River Chapter of the National Contract Management Association and a member of the local PTA and Booster's Club. He is married and has two children.

ROBERT J. STOHLMAN is Assistant for Acquisition Policies to the Deputy for Materiel Acquisition. In that position he participates in Secretarial reviews of Army weapon system programs from conceptual stage through deployment, advising the Deputy for Materiel Acquisition on Selected Acquisition Reports, System Development Plans, Program Management Plans, Presentations to the Army Secretariat or OSD and other program-related reviews. Mr. Stohlman is responsible for providing advice to the ASA (I&L) and other elements of the Secretariate and DA Staff on acquisition management policies for Army Acquisition programs in connection with hearings before, or surveys and reports by, Congressional committies, General Accounting Office or Industry reviews and reports concerning the Department of the Army policy and practices for managing the weapon systems acquisition process. Mr. Stohlman has been on the staff of the ASA (I&L) for eight years and has held various other procurement and materiel acquisition related positions within the Army for the past twenty years. He holds a Bachelors degree in Business Administration.

DANIEL E. STRAYER LtCol, (M.B.A., PhD., The Ohio State University) is Executive Director of the Air Force Business Research Management Center. Receiving his commission through ROTC at Ohio Wesleyan University, LTC Strayer served as Procurement Officer at Aeronautical Systems Division and the European Office of Aerospace Research. After duty as a faculty member at the US Air Force Academy and completion of graduate training LTC Strayer joined the staff of the Air Force Logistics Command's DCS/Procurement and Production, as Chief of the Pricing and Negotiation Division. He moved to the Business Research Management Center in September 1974. Initiator and founder of PIECOST, LTC Strayer has been involved in research and consulting on various aspects of the acquisition process since 1967. LTC Strayer has completed the Air Force Command and Staff College and is an NCMA certified professional contract manager. His awards include the Air Force Meritorious Service Medal with one Oak Leaf Cluster.

WILLIAM E. SOUDER Doctor, is a well-known authority in the fields of R&D management, systems analysis and organization behavior. He teaches courses in systems management engineering, organization behavior and applied operations research at the University of Pittsburgh, where he is Associate Professor or Industrial Engineering and Director of the Technology Management Studies Group. He has a BS With Distinction in Chemistry, an MBA, and a Ph.D. in Management Science. His research studies in the use of operations research models for management planning and his studies in the behavior of organizations, which he began nearly ten years ago, have been supported by the National Science Foundation, the Army research Office, the National Aeronautics and Space Administration, and several industries. He is the author of over fifty research papers and monographs in the R&D management field, the editor of the Joint IEEE Trans./R&D Management Journal Special Issue and chairman of the College of R&D Management in the Institute of Management Sciences. He is also on the editorial boards of the IEEE Transactions on Engineering Management and the AIIE Transactions. Prior to joining the University of Pittsburgh in 1972, Dr. Souder taught at Northwestern University and at Bradly University. He has over twelve years of industrial experience with the Monsanto Company, where he served as Lubricant Chemist and Project Manager. Dr. Souder is also founder and principal associate of Scientific Management Associates, a consulting firm with extensive experience in systems design work for the National Aeronautics and Space Administration, the US Army Corps of Engineers and a number of industries.

PARTICIPANTS

ABSTRACTS

ABSTRACTS

ABSTRACTS (cont'd)

THE INFORMATION ECONOMICS OF

PROCUREMENT DECISIONS

By: Albert Bruno, Associate Professor and
Project Director,
Robert Bowen, Assistant Professor,
Leigh McAlister, Research Associate,
Shelby McIntyre, Assistant Professor,
all of the University of Santa Clara

JULY 1976

The Information Economics of Procurement Decisions

ABSTRACT

Each year a substantial portion of the federal budget is committed to the expenditure of funds in the private sector. The goods and services supplied by private industry to meet this federal demand are widely diverse. Those that are technologically sophisticated, that tend to have a high degree of cost and performance uncertainty, that are prone to rapid obsolescence, and that have requirements for large capital expenditures have led to a specialized contractual agreement between the government and the private contractor. The bilaterally negotiated procurement contract, has spawned a variety of contract types such as CPFF, CPAF, CPIF, and others. These contract types have been developed specifically to accommodate complex contract requirements and to insure that both parties can expect acceptable reward and risk tradeoffs. The communication process between the government and potential contractors prior to the awarding of a contract is of critical importance in the determination of all decisions that follow (funding level, contract type, contractor choice, etc.). Heretofore, the information flow has been treated as an implicit consideration rather than as an explicit and critical variable in the procurement decision process.

In his book, Information Analysis, Joel Demski develops the basic information Economics model which can be specialized to the defense contracting environment as follows.

The government; embodied in the technical monitor, procurement officer and other relevent persons; will be viewed as a single decision maker (DM). All technical expertise and previous experience with the contracting process and agents is collectively called DM's "prior." Based on this prior DM may request from the contractor anything from no information (as is the case with off-the-shelf purchase requests) to very detailed cost or specification estimates (state-of-the-art purchase requests).

Each contractor is characterized as an information system made up of his personnel, accounting system and internal procedures. Given that DM has requested information (asked for cost estimates for a

shuttle craft, for example), the information system produces a signal -- that contractor's estimate.

The DM combines its prior with the signal generated by a given contractor in a statistically consistent manner yielding a "posterior" body of knowledge. Based on this "posterior" the DM will either seek more information or make a decision. Typically the decision would be whether or not to let the contract to this particular contractor.

Information can thus be viewed as a commodity. The desired amount of information to be consumed, then, is an optimization problem conceptually similar to single person decision theory. The DM is assumed to be able to specify alternative actions (let contract/don't let contract), states (a set of mutually exclusive and collectively exhaustive possible scenarios describing the world at some specified future point in time), probabilities of states, and the utility associated with each action given that a particular state occurs. The DM then selects the action that gives the maximum expected utility.

Several insights can be gleaned from this model. The value of information for instance, is a fundamental concept. Incorporation of the uncertainty surrounding the specifications and costs in a state-of-the-art project is tractable.

The information economics framework focuses on the information system from which signals emanate. Previous analyses have typically taken the information system as exogenous. Focusing on the information system reveals that it really has two component parts:

a) the information configuration (i.e., what attributes are to be reported in what format, etc.),

b) the information system (i.e., the procedure used to produce the final signal which conforms to the information configuration).

Information economics draws attention to the fact that the signal emitted from an information system has little meaning without some information about the system that generated the signal. Traditionally, the government has processed signals without explicitly evaluating their source. Procurement procedures must be concerned with the information systems that are exercised by contractors.

Furthermore, information economics points out the fact that the components of the decision model $\{A, S, \Phi, U, \varepsilon\}$ are all of importance.

The most efficient commitment of resources would be to that element of the decision model which yields the largest expected utility. This suggests a contract bidding perspective which subsumes the "bid-to-spec" and "bid-to-cost" procedures as special cases of a more general framework.

ABSTRACT

ASSESSMENT OF PROJECT IMPACT OF CHANGES

A.M. Feiler, UCLA

The paper discusses the problems of managing configuration/engineering changes and, in particular, the key task of assessing the project cost and schedule impacts of proposed changes. Critical path network analysis is frequently used to assist in quantifying the project impacts of changes. However, conventional critical path techniques invariably produce inaccurate results because they are deterministic; they do not account for project uncertainties and variability of performance.

Using recently developed probabilistic network techniques which can account for project uncertainties and performance variability, an example project network is analyzed to demonstrate the significant differences between results obtained with deterministic and probabilistic network analysis techniques. The example analysis demonstrates that:

1) Deterministic network analysis for a project with significant uncertainty and performance variability produces schedules which are optimistacally biased.

2) Deterministic impact analysis:

   a) Overstates the project impact for changes affecting activities on the deterministic "critical path," and

   b) Understates the project impact for changes on some of the other paths. Such results are typical for all projects with significant uncertainty and performance variability.

A CONCEPTUAL MODEL FOR EVALUATING CONTRACTOR MANAGEMENT DURING SOURCE SELECTION

F. Theodore Helmer, USAF Academy
Robert L. Taylor, USAF Academy

Abstract

This report provides the reader with a conceptual model for evaluating a contractor's management potential during source selection. The model is not a definitive outline of what must be done; rather, a discussion of a number of the variables that ought to be considered. The reader can then include only those variables most relevant to the task at hand. The model, then, should be viewed as a thought triggering device for source selection panels to define and structure contractor management evaluation during the source selection process. The evaluation of contractor management is divided into three major functional areas: planning, organizing, and controlling. A checklist of variables under each topic is included in the report, with examples of a numerical scoring system, a color-coded evaluation system, and a descriptive adjective evaluation system. The report concludes with a detailed example of a complete source selection numerical scoring system, including technical, cost, management, quality, reliability, experience, facilities, and contract evaluations. This report should be invaluable to organizations entering into source selection.

SEQUENTIAL RESEARCH NEEDS IN EVOLVING DISCIPLINES IN THE SOCIAL PRACTICE OF PROCUREMENT*

by
Joseph L. Hood, Ph.D.
Defense Systems Management College

INTRODUCTION

Much of the effort toward a broader definition of research in procurement seems to present the perspective toward research in a single time dimension. Is it possible that the research needs of a field of study and practice also vary over time?

Criticism has been leveled at procurement by scholars of older disciplines for the naivete of that research. Reactions to these criticisms have been a combination of guilt feelings, defensiveness and scapegoating. It is true that research in procurement is mostly descriptive, with heavy emphasis on surveys, case studies and reports of artistic experience; and it ought to be more analytical and experimental (guilt feeling). But pioneers who are so busy building a new field don't have the time to engage in more scientific research (defensiveness). Besides, it may be the fault of the older disciplines that procurement research is in the state it is--they haven't shown enough interest in our field to bring their discipline to bear on it (scapegoating).

*The contents of this paper are adapted from Malcomb S. Knowles' speculative theory for "Sequential Research Needs in Evolving Disciplines of Social Practice," Adult Education, XXIII, 4, 1973.

The growth of a field of social practice like procurement is a genetic process which proceeds as if by natural law according to an organically-determined sequence of phases of development. A field of social practice may have developmental needs that change through the stages of maturation. So, what are the developmental needs for research for evolving fields of social practice of procurement?

Consultants and students, in their constant quest for research problems that would be relevant to the needs of the field of procurement, seem to look introspectively at problems and concerns they or their institutions have existentially. They seem to search the periodical literature to discover needs as perceived by the leaders of the field. They seem to explore the research problems being studied in related fields for clues as to what the procurement field ought to be concerned with. These are good sources for building a master list of possible procurement research problems. But what many have been asking for is a criterion for helping them select from the list those problems that would be in tempo with the developmental needs of the field. And this we have not had.

Toward filling this void, a theoretical construct of sequential research needs in evolving disciplines of social practice is presented in the form of six phases.

DEVELOPMENTAL NEEDS FOR RESEARCH IN PROCUREMENT

Phase 1: Definition of the Field

The first organic need of a field of social practice of procurement is for a definition of itself. As the pioneers of a new kind of social practice start becoming aware of the fact that they are doing something different and start bumping into others who are doing much the same thing, they begin to get a sense of identification with one another. And then they start asking such questions as: Who else is doing this kind of thing? How many are there? Where are they located? What types of institutions are they in? What, exactly, are they doing and how? What are their objectives? Who are their clients? What terminology are they using to describe themselves and their work? Under what conditions are they working? What are their resources? What are their problems and concerns? What are their characteristics? In what directions are they moving? These and other questions arise out of the natural need for a new field to know itself--to become defined. The field of procurement practice needs to be able to describe itself before it can present itself with integrity.

Accordingly, during this phase the great need is for descriptive research--descriptive surveys, census studies, case reports, demographic studies, and the like.

Phase 2: Differentiation of the Field

As a field becomes fairly secure about its self-identity, it begins to experience a need to differentiate itself from other fields of social practice and to clarify its relationship with them (such as procurement with the fields of accounting and law). It has to be able to answer such questions that are directed to it as: Exactly how is it different from other, related fields of social practice in its goals, values, auspices, clientele, and methodology? In what ways does it compete with them versus complement them? What unique social needs is it meeting that can't be met equally well by established fields? What right does it have to claim special resources for itself? What specialized training or talents are required to engage in its field of social practice?

During this phase there is need for (1) comparative studies that delineate roles and technologies among the fields of practice, (2) exploratory research that probes boundaries, (3) reports of artistic practice that establish uniqueness of approach, and (4) analyses of needs.

Phase 3: Standard-Setting

Once a field of social practice is clearly defined and differentiated from other fields (in a sense, once its right to membership in the applied social sciences is established), it becomes concerned with the problem of control (such as the requisite practice for the procurement practitioner). It now addresses itself to such questions: What are the standards of practice now observed? What should be the minimum standards of practice? What outcomes are actually being achieved through its practice? What are appropriate criteria for evaluating the effectiveness of its practice? What procedures should be used for measuring its effectiveness? What sanctions are available and effective in maintaining accepted standards? How should training institutions be accredited and practitioners be certified?

During this phase the greatest need is for (1) normative-descriptive research which yields insight as to desirable standards, (2) evaluative research which appraises the outcome of both training and practice, and (3) instrumental research which provides improved tools and procedures of measurement.

Phase 4: Technological Refinement

As a field begins to get feedback from its evaluative research it discovers areas of weakness in its technology. Many of the methods it has been using are found not to be producing the desired outcomes. And so a need develops for improvement of its technology (such as the use of new procurement techniques).

During this phase the need is for (1) experimental research which tests the relative effectiveness of different approaches, (2) case studies which deepen the understanding of the dynamics of the technology, and (3) action-research which continuously infuses the technology with the insights of reality.

Phase 5: Respectability and Justification

As a field gains the stability that comes from definition, differentiation, standard-setting, and technological refinement, it develops a need for status and esteem. It has satisfied its needs for survival and safety and now strives for recognition as a field worthy of respect.

During this phase the need is for (1) historical research which provides the respectability of accumulated experience, (2) biographical studies which cast the aura of illustrious figures on the field, and (3) field-evaluative studies which demonstrate the effectiveenss of the field in accomplishing its goals. During this phase, also, there is need for a more sophisticated round of survey-descriptive and comparative studies to show how far the field has matured since its original definition and differentiation.

Phase 6: Understanding of the Dynamics of the Field

Once a field has beocme well established and is esteemed, it develops an organic need to understand the internal and external forces that are affecting its development. It now raises such questions about itself as: What are the functional elements of the field and how should they be organized into a unified system? What are the resistances to change in the field? What are the changes in society to which the field should be responding? What are the societal models the field should be trying to work toward? What are the processes by which the direction of movement of the field is determined; and what should they be?

During this phase the need is for (1) institutional studies which will shed light on the internal structure and stresses of the field, (2) environmental studies which will identify societal trends to which the field should be responding, (3) force field analyses which will reveal resistances to change, (4) systems analyses which will indicate the interrelationships among the elements of the total system, and (5) prediction studies which will project alternative directions of future movement and test their consequences.

This conception of the developmental needs for research in a field of social practice such as procurement can be summarized schematically as follows:

Phase	Organic Need	Relevant Research
1.	Definition of the Field	Survey-descriptive studies Census studies Case reports Demographic studies
2.	Differentiation of the Field	Comparative studies Exploratory studies Reports of artistic experience Need analysis
3.	Standard-Setting	Normative-descriptive studies Evaluative research Instrumental studies
4.	Technological Refinement	Experimental research Case studies Theory-building Action-research
5.	Respectability & Justification	Historical studies Biographical research Field-evaluative studies Survey-descriptive studies Comparative studies
6.	Understanding of the Dynamics of the Field	Institutional studies Environmental studies Force-field analysis Systems analysis Prediction studies

QUALIFICATIONS

There are two qualifications to the presentation of this construct so far. In the first place, don't view the phases to be as distinct and separate as this method of exposition makes them appear. It may be functional to have overlapping between two or three adjacent phases. For example, while a field is working focally on its definition, there may be some work going on legitimately on differentiation and perhaps even on standard setting. Research aimed at understanding the dynamics of the field (Phase 6) may have doubtful relevance or acceptability while the field is primarily concerned with defining itself (Phase 1).

In the second place, don't view these phases to be linear; rather, see them as being spiral. An evolving field needs to move through the six phases a first time fairly superficially and then to repeat them in ever deeper cycles. The time-span for each cycle may become shorter and shorter.

THE USES OF THIS CONSTRUCT

This theoretical construct is presented in the hope that it will be used in at least two ways.

First, it should be put to a rigorous intellectual test. How do these speculations stand up in the light of your experience, intuition, and logic? Does the very notion of genetically-determined phases of development of a field of social practice make sense to you? If not, what alternate guidelines to the patterning of research make more sense? If the idea of the developmental phases does make sense to you, how do the six phases hold up in your thinking? Would you put them in this sequence? Would you add other phases? And do you agree with the relevant types of research for each phase?

Second, the theory should be tested empirically. Researchers should try to apply it to the selection of research problems and should report whether or not it holds up as a criterion of relevance for procurement in its different stages.

William R. Leak
DCRL-GVQT
Defense Contract Administration
Services Management Area, Van Nuys
6230 Van Nuys Blvd.
Van Nuys, CA 91408
(213) 997-3281

ABSTRACT

Procurement Quality Assurance of Computer Software

There is general agreement among those buying computer software for the government that quality assurance must in some way be performed. By whom, is more difficult to resolve. There are very few people truly proficient at both quality assurance and computer programming. Those that are, are spread so thinly as to be unable to give any one program the coverage it should have. All proposed plans to resolve this manpower problem will require many years to be fruitful. Meanwhile, 3 billion dollars of special-purpose computer software is being built, and bought, with the value predicted to rise swiftly.

Fortunately, the quality assurance professional has a number of tools and controls that can compensate to a large degree for lack of technical expertness.

The easiest conventional QA function to perform is the pre-award survey. It is possible to perform a meaningful review of a company's quality system and quality history with a small amount of technical knowledge of the item under consideration, even for software.

The next easiest function to perform is pricing. With a simple understanding of how programming is estimated, and the cost of software QA in general, it is possible to estimate the reasonableness of the quality assurance portion of a software proposal.

The functions of a surveillance and acceptance are the most difficult. Mil-Q-9858A provides some coverage, particularly after configuration starts. The new Mil-S-52779 adds coverage of work tasking and scheduling.

Established practices of quality assurance may never be adequate to fully surveil computer software. The generation of a large software system is a massively complex project, comprising research, design, development, prototype, and first article all in one. As mentioned above, conventional quality assurance is most meaningful in the later stages, when the software is configured. By this time errors have become too expensive to fix, and the software too expensive to discard.

It is proposed that entirely new concepts and techniques may have to be derived to assure the quality of computer software.

ABSTRACT OF THE PAPER

Dr. George Lenches, Director
Office of Planning and Development

The origins of "renegotiation" go back to World War II when, in an attempt to limit profiteering by defense contractors, provisions were made to renegotiate contract prices in the light of subsequent developments. This was repricing pure and simple, on a contract-by-contract basis. Consideration of administrative feasibility, however, forced the abandonment of that concept almost immediately and within six months "renegotiation" was in fact put on an aggregate fiscal year basis. With that step, the metamorphisms of "renegotiation" began, with only the name remaining constant--and a constant misnomer.

Logically, renegotiation on an aggregate fiscal year basis cannot be a repricing tool, since its effects on individual contract prices--and profits--are in practice indeterminable; also, in the presence of several contracts it cannot result in contract prices that could be called "fair and reasonable" if the contracts were considered separately. Thus renegotiation, from early on, became a general policy tool of the Government, operative in the area, but not an adjunct of the procurement process.

The 1943 Act, which is the foundation of present-day renegotiation, was fully compatible with this altered--non-repricing--form of "renegotiation". In spite of that both

the name and, much more importantly, the justification of renegotiation remained as before: renegotiation continued to be presented as a repricing tool well into the 1960's and the inability adequately to estimate costs, often translated as a procurement weakness, continued to be the key element in the justification of renegotiation.

With the passing of the Korean war, this lack of understanding of renegotiation's true nature resulted in the cutting back of the renegotiation authority's jurisdiction, through the elimination of some of the "named" agencies and the enactment of exemptions; it also caused repeated short-term extensions of the Renegotiation Act of 1951, the enabling legislation, usually justified by the ever-elusive hope that "improvements" in the procurement process will somehow soon make renegotiation superfluous.

It was not until the late 1960's that a more realistic description of--and a more valid reason for--renegotiation appeared, accompanied, not surprisingly, by a request for the repeal of a significant exemption. The fading of the repricing concept and the continuing articulation of renegotiation as a Governmental tool for ensuring comparability of economic behavior in the private and the Government procurement sector led in due time to the logically incontestable recommendations to extend renegotiation to all Government agencies and to make renegotiation a permanent part of the Governmental system.

The basic justification for renegotiation is that Government procurement, to a very large extent, is derivative of policy decisions, and not of market considerations, and thus the mechanism of the competitive markets is not normally, or not fully, operative under conditions surrounding Government procurement. Consequently, under even the best of circumstances, "excessive", i.e., unearned profits may arise. Such extra-market rewards are, of course, undesirable, both because they improperly enrich suppliers and also, perhaps what is equally important, because they improperly affect competitive relationships among firms in and out of the Government procurement market.

The Renegotiation Act of 1951 is, on balance, an adequate vehicle for the purpose of effecting the goals of renegotiation. Specifically the "statutory factors" provide an acceptable basis on which to judge the excessiveness or non-excessiveness of contractors' profits. Technical improvements in the language of the law and its administration are feasible, but the most important current need is to obtain stable conditions under which the Renegotiation Board can perform its duties in an environment of mutual understanding of goals and policies.

The relatioship between renegotiation and procurement should not be ambivalent any more. Renegotiation is not an adjunct of procurement; it is a separate, independent

Governmental tool designed to prevent or counteract the ever present danger of distortions of competitive forces in the Government procurement market.

The Measurement of Economic Efficiency in
the Defense Aerospace Industry

ABSTRACT

M. Brian McDonald, Capt, USAF

This study explores a methodology which can be used to develop economic efficiency or productivity measures for contractors in the defense aerospace industry. The technique used to derive the productivity measures is a cross-section linear programming estimation of a Cobb-Douglas economic production function for the sample. A production function expresses the technical relationship between the maximum output obtainable from a given combination of inputs. The estimated production function establishes a "potential" output for each contractor. The productivity measure is the simple ratio of actual output to "potential" output, and will be a number less than or equal to one.

The linear programming procedure minimizes the sum of the simple deviations of the sample points from the estimated line and at the same time constrains all the sample points to lie below the estimated production function. Starting with the Cobb-Douglas production function:

$$Y = AL^{\alpha}K^{\beta} \tag{1.1}$$

where Y = output (value added)

L = labor input

K = capital input

A, α, β = parameters of the production function to be estimated

We take logarithms of both sides of (1.1). We can rewrite it as:

$$\log Y = \log A + \alpha \log L + \beta \log K \tag{1.2}$$

The estimating problem, then, is to find estimates of log A, α, β in (1.2) such that we minimize the sum of $(\log \hat{A} + \hat{\alpha} \log L_i + \hat{\beta} \log K_i - \log Y_i)$ and such that $\log \hat{A} + \hat{\alpha} \log L_i + \hat{\beta} \log K_i \geq \log Y_i$.

Expressing the problem in matrix notation:

$Y = XB$ where $Y = [Y_1, Y_2 \ldots Y_n]$

$X = [1, \log L_i, \log K_i]$ $i = 1, 2 \ldots n$

$B = [\log A, \alpha, \beta]$

The linear programming problem is:

$\min \ell'e = \ell' (XB-Y)$ where $\ell' = [1, 1, 1, \ldots 1]$

subject to $X \hat{\beta} \geq Y$

$\hat{\beta} \geq 0$

Sixteen aerospace contractors over which AFCMD has responsibility for contract management are included in the study. Data used in the estimation procedure include value added for output, total labor head-count for labor input, and either total square footage of plant, acquisition cost of capital or fire insurance value of capital for capital input. All data are for the contractor's fiscal year, and include both government and commercial work. Adjustments are made to labor input to account for contractor differences in stage of production (i.e., R&D versus full scale development). Adjustments are made to capital input to account for degree of utilization and second shift work.

Data were collected for three years - 1973, 1974 and 1975. For each of the three years a separate aerospace group production function was estimated and a productivity or efficiency measure was derived for each contractor for each year. Using 1973 as a base, the three efficiency measures for each contractor were linked together to form a productivity index series for an individual contractor. Productivity comparisons between contractors are possible within any year by comparing relative efficiency measures for that year. More meaningful productivity comparisons, however, would look at the movement over time in a contractor's productivity index series. Work was also done to estimate a separate production function for airframe and missile manufacturers. It turns out that this is the appropriate procedure because the two functions do differ.

At present we still have some major problems to deal with, and really have more problems than solutions to offer. This project has been a two-stage project. In 1975 - Stage I - we applied the technique to 1974 data to test its feasibility. We were encouraged by the results and in 1976 - Stage II - we expanded the scope to a time series analysis. We gathered 1973 and 1975 data and asked that the previously collected 1974 data be reverified. We found many instances of major corrections to the 1974 data, especially in the capital area. We realize that we still have not done a satisfactory job of defining data elements - a difficult thing to do in any case - and it may require individualized collection of certain data items.

In the estimation of the airframe function, we found that the capital variable did not enter at all in the final solution. Labor input was the sole determinant of output. This result indicated to us a problem with our output measure - value added - especially at GOCO plants. Costs, such as depreciation, associated with capital items which normally get incorporated into a contractor's costs and hence his sales (and value added), are not included in the sales of contractors at GOCO plants. Thus actual output, as we have defined it, at GOCO locations is lower than if the contractor owned the entire plant. We think this explains why capital did not enter the airframe production function and believe it can be corrected by making an adjustment to output for imputed rent of government owned plant and equipment.

Another significant problem we must deal with yet is the apparent instability of the production function over time. We estimate a production function at three points in time - 1973, 1974, 1975. We expected the coefficients - A, α, β - to be similar year-to-year. However, we have found major variations in the coefficients, indicating instability in the function. This could be due to data accuracy problems, but at this time we do not have a satisfactory answer.

The productivity of a contractor is an important indicator of the performance of an organization and its management. A productivity measure could provide a useful input into source selection and award fee decisions. Knowledge of the relative efficiency of contractors can also serve as a guide for AFCMD in manpower alloation decisions. Time series productivity measurement will also provide the means to analyze the results of the collective efforts to both industry and government to improve productivity in the defense aerospace industry.

ENCOURAGING INNOVATION AND TECHNOLOGY TRANSFER

FOR NEW PRODUCT DEVELOPMENT:

The Federal Supply Service PRIM System

by James B. McNallen, Peter C. Boulay, and Theodore J. Fody

ABSTRACT

The business of the Federal Supply Service of the General Services Administration is to provide and sell common-use, nonpersonal products to other federal departments, agencies and bureaus. Most products sold by Federal Supply are essentially standard and have a low-technology content.

Manufacturers supplying these products visualize an extended life-cycle for their products and few technology changes or product improvements. Traditionally, most government procurement has focused on design specifications and purchasing products on a least-cost basis. Thus, there has been little incentive for manufacturers to provide new or improved products for government markets.

The Federal Supply Service does not have a research and development or product development function as currently organized. The proposed PRIM System (acronym for Product Improvement Intervention System) was recently developed by an outside contractor. Its purpose is to try to encourage private sector vendors of these products to undertake efforts at innovation new technology, and technology transfer to develop new and improved products. In exchange, the Federal Supply Service would provide a number of incentives, including purchase of these products for resale to its customer agencies and help in establishing the new and improved products' viability for successful commercial introduction in private sector markets.

The two objectives of the Federal Supply Service PRIM System are: (1) to provide new and improved products to its own $1.5 billion annual market represented by government agencies buying centrally; and (2) to encourage growth and the economic vigor of the private sector firms that offer these products to Federal Supply.

The Federal Supply Service PRIM System is based on innovation theory, diffusion theory of new ideas, concepts and products, and technology-transfer theory. The system assumes that incentives can be provided across a wide range of product development activities involving innovation, diffusion, and technology-transfer. It also assumes that these incentives can be tailored to assist and encourage private sector firms to emphasize these areas.

Four subsystems comprise the Federal Supply Service PRIM System: (1) the Suggestion Subsystem; (2) the Procurement Techniques Subsystem; (3) the Implementation Subsystem; and (4) the Assessment Subsystem.

The Suggestion Subsystem is designed to elicit ideas for needed new products and product improvements from a variety of sources. These suggestions are solicited in areas determined by Federal Supply management. Methods of soliciting ideas include distribution of product idea kits, sponsorship of product improvement and procurement technique seminars, and surveying customers and potential customers. A series of screening criteria are used to narrow the suggestions to those most likely to prove successful.

The Procurement Techniques Subsystem is intended to provide proven procurement techniques for spurring innovation, new technology, technology transfer, new product development, and product improvements. The subsystem also provides for developing new procurement techniques, or combinations of techniques. Some will serve particular product or commodity areas while others may serve particular types of present or prospective suppliers (e.g., small or minority businesses). This subsystem matches procurement technique as an incentive to the particular product or commodity area selected for further development.

The Implementation Subsystem visualizes using the Federal Supply Service's buying power, marketing, communications and distribution system in experiments to help participating private sector firms test the demand for their new or improved products. This would be done by running experiments to test the demand for the product concept and delivery and its acceptability for use by Federal Supply's customer agencies.

The Assessment Subsystem provides for current-information feedback and evaluation of the success of the marketing experiment. Experiments, generally, run for one year. During this period, quarterly progress reports would be provided. A final evaluation report would be prepared at the conclusion of the experiment.

The various parts of the Federal Supply Service PRIM System would be integrated through a manager who would report to a PRIM Management Board, comprised of senior executives of the Federal Supply Service. The board would choose the product areas to be emphasized, decide on the ideas or concepts for further development, determine policy for conducting experiments, and provide the final evaluation of these experiments.

\- - - - - - - - - - - - - - -

OVERHAUL AND MODERNIZATION M48A1 to M48A5 MEDIUM BATTLE TANK

THE ARMY DEPOT SYSTEM, A VIABLE ALTERNATIVE
Condensed Version

BY

Daniel G. Mehney
United States Army Tank-Automotive Materiel Readiness Command
Procurement and Production Directorate
Systems Procurement Division
Warren, Michigan 48090

OVERHAUL AND MODERNIZATION CONVERSION
M48A1 TO M48A5 MEDIUM BATTLE TANK
Condensed Version

The Army Depot System, A Viable Alternative

The following discussion on "The Army Depot System, A Viable Alternative" addresses an actual case in which the circumstances virtually found industry in a price competition with a Government Owned-Government Operated facility (GOCO), the Anniston Army Depot, Anniston, Alabama. The discussion will systematically present the background of the requirement, the evaluation criteria, the conclusion of the source selection, the primary complaints raised by industry, and some concluding observations.

BACKGROUND

The program and the procurement action, although not unique in itself, raised some singularly important issues which are worthy of review by the procurement and Government procurement policy community. The action involved overhaul and modernization conversion of M48A1 to M48A5 Medium Battle Tanks. The initial requirement for 849 vehicles represents approximately $61,000,000 in overhaul, conversion, kit hardware and transportation to the selected manufacturer, with potential follow-ons and deliveries through 1980, providing for a program substantial in value and stability.

The M48A5 Tank is a 53 ton vehicle; it is powered by a diesel engine, and is equipped with a 105MM main gun. The secondary weapon is the M2 caliber 50 cupola machine gun, and in addition there is a M219, 7.62MM coaxial mounted machine gun. The M48A5 performs in the capacity of a main battle tank. Modernization conversion of the M48A1, which was built in the early to mid-1950's, requires dieselization and upgunning from a 90MM to a 105MM with related fire control.

Three areas relevant to the procurement community surfaced during the course of the evaluation: (1) the evaluation criteria defined and used by the Army; (2) evaluation of offers to accomplish the program under varying pricing structures; and (3) from an overall defense posture, the retention of industrial sources for future Department of Defense requirements.

EVALUATION CRITERION

The M48A1 to M48A5 Overhaul and Conversion Program would historically have been accomplished in the Army Depot System which is planned and capable of performing such programs. In this case, in order to assure that the program would be accomplished as rapidly as possible and at the lowest cost to the Army, industry was solicited to submit proposals for ultimate comparison to the cost to accomplish the program in the Depot. The Army concluded that the development of an evaluation criterion and the resultant analysis would be accomplished under the authority of the ARSENAL STATUTE, 10 USC 4532, which states: "The Secretary of the Army shall have supplies needed for the Department of the Army made in factories or arsenals owned by the United States, so far as those factories or arsenals can make those supplies on an economical basis." There are no other specifics or implementing instructions relative to the Arsenal Statute. The criterion defined was structured within these general parameters and the principles of BOB Circular A-76, was specifically tailored to reflect a final evaluation based on the actual cost that the Army would have to pay to accomplish this program. The resultant selection, after assurance of technical capability, was determined by the lowest cost to the Army. In accomplishing the selection, the following steps were followed:

1. The Solicitation, Request for Proposal (RFP) was released to industry and the Depot.

2. The RFP included a normal evaluation of industrial firms in accordance with Armed Services Procurement Regulation (ASPR) 3-501(b), Section D.

3. A cost-plus-incentive-fee proposal was requested for the nonrepetitive overhaul effort, and a fixed price with economic price adjustment proposal was requested on the known or repetitive portion of the effort. The Anniston cost estimate was based upon "out-of-pocket cost," and would be compensated on a cost reimbursement basis.

4. The selection process was accomplished in two steps. The first included an evaluation of commercial contractors to determine the lowest commercial price. A step two evaluation was accomplished in which the lowest out-of-pocket cost to the Government was determined between the low industrial offeror and the Anniston Army Depot.

5. The RFP provided for cost comparisons of the overall low industrial proposed contract price, without consideration of Government-owned production and research property, to the out-of-pocket cost to the Government to have the Anniston Army Depot accomplish the total program. The Anniston Army Depot cost estimate was prepared in accordance with Army Industrial Fund Accounting requirements and included the following cost elements:

(a) Personnel and related fringe benefits.

(b) Materials, supplies and utilities.

(c) New production equipment, special tooling and special test equipment.

(d) Maintenance and repair.

(e) New structures.

(f) Overhead expenses.

(g) Installation operation cost.

(h) General and Administrative cost.

Depreciation of equipment and structure was excluded from the out-of-pocket cost definition due to their experienced nature.

The out-of-pocket cost definition and the inclusion of Anniston as a viable source was not contested under the Arsenal Statute. Such an approach has been endorsed by the Comptroller General of the United States in Comptroller General Decisions B-143232, dated 15 December 1960, and B-175703, dated 23 July 1973.

SOURCE SELECTION

Two industrial proposals, both of which were from Government Owned-Contractor Operated facilities (GOCO), and the cost estimate from the Anniston Army Depot were received on 1 May 1975.

Extensive and complete technical fact finding and price negotiations were conducted with all prospective manufacturers including the Depot. The conclusion reached was that it was significantly less expensive, by 22%, to accomplish the program in the Depot than with the lowest-priced responsive, responsible industrial offeror.

INDUSTRY COMPLAINTS

The following primary complaints from industry were largely in the form of Department of Defense Management and Congressional level inquiries and review.

(a) The Army, in its evaluation, should have taken into consideration the use of incremental overheads or the potential savings to the Government through collateral type cost or savings on other Governmental programs.

(b) Industry desired consideration for potential tax revenue benefits that would result from prospective profits from accomplishment of a successful program.

(c) Industry complained that pricing structures under which they and the Depot would operate were at variance; that is, a portion of the price would be fixed for industry and the same portion, (approximately one third) would be cost reimbursed to the Depot. As such, there was a potential built-in overrun in the Depot estimate.

(d) Industry requested special consideration because of the potential increase of 1300 jobs with secondary effect, in a depressed employment area.

(e) The last complaint addressed the overall availability or desirability for retention of an industrial source for supplying battle tanks, a limited resource, and other potential future requirements of the Department of Defense.

The complaints were answered without further challenge on the following basis: (1) selection was made based upon the lowest actual expenditures to the Army to accomplish this program; (2) potential collateral savings or benefits were not legitimate items for evaluation. The Armed Services Procurement Regulation requires independent contract pricing and evaluation; such savings were speculative at best and were not considered for any manufacturer; (3) regional employment impact was the same for all manufacturers; (4) a detailed analysis was performed on all prospective manufacturers; and (5) industrial base retention was considered at best a temporary condition.

CONCLUDING OBSERVATIONS

In conclusion, the Army found that:

1. The Depot System, in particular the Anniston Army Depot, has proven to be a viable technical and cost competitive source for accomplishing major combat vehicle overhaul and conversion programs.

2. Specific guidance needs to be developed and implemented for accomplishing economic analysis between GOGO and GOCO's under the purview of the Arsenal Statute. Such guidance and evaluation criteria should consider the peculiar nature of these manufacturers and their relationship.

3. Consideration, other than on an "out-of-pocket cost" basis, may provide a viable option in assessing overall Government cost, when accomplishing economic analysis between GOGO's and GOCO's under the Arsenal Statute. In particular, measurable collateral savings from other Governmental programs and/or the use of incremental overheads may be appropriate for consideration.

4. The "out-of-pocket cost" analysis of actual expenditures in the GOGO vs GOCO environment surrounding the M48A1 to M48A5 program, without consideration for prospective savings on other programs or expended facility cost, has proven to be a reasonable and logical approach in obtaining a manufacturing source at the lowest possible cost to the Army.

Postulated resolutions to the issued and considerations involved in obtaining effective competition between a profit based industry and a Government subsidized Depot-Arsenal system, have not been provided. However, the issue is a real one; it lies behind the actions that have been discussed. The issue and considerations demand attention and are of utmost importance to the retention and fostering of an industrial base prepared to meet the demands required of a strong defense posture.

An economic analysis approach with placement conclusions after competition, has in the case of the M48A1 to M48A5, proven costly to industry and to the Army in expended resources. It has proven to be time consuming and slowed the selection process by six months. The industrial manufacturers who participated would probably decline to submit future proposals under similar circumstances were a Government Owned-Government Operated facility is involved. This is premised on the nature of their organizations and that of the Depot, for industry has expressed the opinion that cost of doing business and accounting for such cost are not comparable and reimbursement arrangements with resulting proposal considerations are at variance. Industry has also commented that when a supplier competes with his customer, the potential of personal bias may be interjected into the selection, ill will may be fostered and communication channels may falter due to program protection tendencies; when your customer becomes your competitor, consideration and relationships change.

A basis for cost comparison studies and conclusions on economics between GOGO and COCO operations does exist under BOB Circular A-76, as implemented, and is accomplished prior to soliciting competitive commercial bidding. Under the requirements of the Arsenal Statute, there is no specific implementing instructions defining what comprises an "economical basis". A clear definition of the considerations is necessary to preclude future complaints and potential inequity. With established criterion, as well as retention of necessary in-house capability can and should be made by management within the Department of Defense without formal or informal commercial competition.

"Grant Management: Federal Accountability or Federal Intervention?"
Robert D. Newton, National Science Foundation

<u>Brief history of federal grants</u>

A number of federal grant programs were created in the last half of the 19th century. Those programs were basically for grants of federal property, usually land. About the turn of the century grants began to be made from general revenues. At first both of these types of grants contained few explicit conditions. But situations arose in which granted property or monies were not used for the purposes intended by the grantor. Grants became "conditional" transactions and thereby legal contracts in the sense that the properties or monies granted had to be used for the purposes intended or the grantor could recover them.

During the first half of the twentieth century grants also came to be regarded as "transfer payments" in which federal funds were provided to units of state and local government to serve objectives established by the Congress. The terms "federal aid" and "grants-in-aid" are associated with the concept of transfer payments. So are terms such as "mandatory grants" and "formula grants," both of which connote Congressional or administrative specification of grantees and/or amounts of awards.

During the past quarter century the research grant, made chiefly to institutions of higher education, has established a type of relationship very similar in its essentials to the transfer-payment relationship. The terms "discretionary" and "support" are associated with the concept of the research grant.

Although there are differences in jargon and process between transfer payments and research grants, the similarities between them are more significant than the differences. When seen in terms of basic relationships, both are modes of federal assistance or support of national purposes accomplished by grantees in keeping with federal standards which can be monitored by after-the-fact program, administrative or financial review.

But the confusion that now exists in the grant world is not just semantic. The confusion that exists has resulted from the introduction of a new factor which has upset both traditional grant and grant-in-aid relationships.

New Grant Programs and the Meaning of "Grant Management"

The nature of federal grants changed significantly during the 1960's. In many grant programs enacted in the 1960's Congress asserted a national interest in a large range of functions and activities.* Achieving objectives to serve those national interests required an enlarged federal role in assistance programs and established a new pattern of federal/ non-federal relationships. This new pattern of relationships is far more complex than those created by earlier grants of property, grants for research support, or grants-in-aid conceived as transfer payments.

Lack of systematic Congressional or Executive attention to these different relationships and to how the complex activities being undertaken are to be implemented has resulted in

* See Chapter 1 of James L. Sundquist and David W. Davis, Making Federalism Work, Washington, D.C.: The Brookings Institution, 1969.

confusion and waste. The Congress intended that the federal agencies intervene in projects and activities to assist in achieving specified national objectives. The Congress realized that this intervention would entail some federal supervision and control. But neither the Congress nor the Executive has given systematic attention to what federal/ non-federal roles and responsibilities should be, namely, who should be doing what and why.

To put the matter another way, the traditional federal grant-in-aid has been regarded as a transfer of funds with the recipient responsible for performance in keeping with federal standards. That concept has been seen as requiring only an audit type of federal review and the trend has been, with increased grantee experience and sophistication, towards reducing the federal role. But, as we have noted, that trend has been complicated by the creation of new programs requiring active federal participation and intervention. There is a need for a passive or reduced federal role in some cases and a need for an active or increased federal role in others.

Some initiatives have been taken. The New Federalism articulated the theme that power, funds and authority should be given to those closest to the people. The Federal Assistance Review (FAR), with its emphasis on consolidation, decentralization, standardization and simplification, was a cornerstone of the New Federalism. Several years ago, the FAR effort proposed to apply simplified standards to the newer complicated programs requiring active federal involvement or participation. Ironically, OMB is now considering an interagency task group recommendation for revision of the procurement standard (Attachment O to OMB Circular A-102) which, if applied to all grants, would result in more Federal intervention by requiring (1) development of grantee procurement systems on the model of the federal system or (2) federal review and approval of significant grantee procurements.

Efforts to simplify grants consistent with the traditional grant philosophy of primary recipient responsibility for performance are frustrated by the need of federal agencies to be more involved in some types of transactions. The key problem is how to implement complex projects and activities requiring significant amounts of federal intervention and participation without losing sight of the large number of other programs which do lend themselves to administrative and programmatic simplification.

We must recognize that we have more than one type of basic relationship. If so, we have more than one way of being accountable. If we can relate to recipients of federal awards in different ways, we also can be accountable for the expenditure of public funds in different ways.

Congressional concern with HEW Health Maintenance Organizations (HMO's) is a good example of the need to recognize alternative federal and non-federal roles. The Congress established a program of federal support to encourage establishment of HMO's. Problems have arisen in the management of these HMO's. Senator Edward Kennedy has queried HEW officials as to why HEW has not moved to assure adequate management of HMO's.* HEW officials have responded that they're a grant dispensing agency and are not in the business of arranging for the management of HMO's. The traditional grant relationship and the grant transfer-payment philosophy do not suffice in this situation. In the interest of effective program implementation HEW should be systematically considering alternative HEW and recipient roles and responsibilities in all activities it supports. For example, federal control similar to that exercised in procurement contracts may be appropriate in some instances; various cooperative or partnership arrangements may be appropriate in other instances; and the traditional grant relationship may be appropriate in others. The Congress appears to be asking HEW for a response that demonstrates systematic consideration of management alternatives in the interest of program effectiveness. But HEW, like most of the executive agencies, is not accustomed to responding to questions on grant management in terms of a system of alternative methods of implementing programs, projects and activities, a system that would assure consideration of what the federal agency should do and what the recipient should do to assure effective program, project or activity implementation.

* See John K. Iglehart, "Health Report/HMO Act Changes Advanced to Bolster Troubled Programs," National Journal Reports, Vol. 7, No. 33 (August 16, 1975), pp. 1161-1166.

The proliferation of federal grant requirements

The proliferation of federal grant programs has been accompanied by a proliferation of federal grant requirements. It is these requirements or "strings" which most exasperate grantees. There are several reasons for the proliferation of grant requirements. The proliferation of novel or complex federal programs has of itself required the development of new standards which tend to draw the federal agencies into new interactions with grantees. The complexity of projects has required federal participation. Construction, demonstration, applied research and development often call for federal operational involvement during performance. In addition, Congressional generation of new public policy provisions, which are now generally applied to grants as well as to contracts, require federal involvement to implement them. Finally, there is another, more difficult to handle reason for the proliferation of requirements: accountability for the expenditure of federal funds.

From a federal perspective: Accountability

From the perspective of the federal bureaucrat the proliferation of requirements is plausible. Congress creates a program. Rules are established to implement it. A problem occurs in its implementation. Something must be done about it. A clause is prepared elaborating requirements and providing for federal review or approval. Federal involvement is thereby increased. It is increased to insure that we as bureaucrats have met our responsibilities for the expenditure of federal funds. Inasmuch as we in the federal agencies get criticized by Congress or GAO when something goes awry, do we have any choice but to attach the strings necessary to insure accountability?

<u>From a recipient perspective: Intervention</u>

The reverse of the coin of accountability, from a recipient perspective, is intervention. State and local recipients of federal grants have for some while deplored federal intervention. But it is not they alone. In his most recent report to the members of its Board of Overseers, the President of Harvard University repeatedly uses the term "intervention" to describe his perception of the federal role in the relationships of the university with federal agencies. He notes that

> "... the rising tide of government intervention has begun to provoke serious concern from many colleges and universities...In a few short years, universities have been encumbered with a formidable body of regulations, some of which seem unnecessary and most of which cause needless confusion, administrative expense, and red tape. If this process continues, higher education will almost certainly lose some of the independence, the

flexibility, and the diversity that have helped it to flourish in the past."*

Recipients of federal grant awards tend to feel helpless, victims of an avalanche of requirements they can do little to hold back.

Can federal accountability and federal intervention be balanced?

Our federal system is a division of responsibilities among federal and non-federal entities. In establishing and implementing procurement and assistance relationships we make role and responsibility decisions. When we elect to use grants rather than contracts, we are in theory making choices which have federalism implications and which in the aggregate should be very significant. In practice they tend not to be very significant because in federal/non-federal relationships the term "grant" has lost much of its original meaning. Grants are now used for purposes different from those for which they were originally used. Instead of clarifying respective federal/non-federal roles, the use of grants often confuses them. A grant has become a less meaningful alternative. It has, thus, become easier to proliferate federal requirements and encourage federal intervention in the name of accountability. Role decisions are made ad hoc and unsystematically.

To be true to our federal system we should be asking: "How do we decide who should be doing what and why?" The

* Derek Bok, "Harvard University: The President's Report, 1974-1975," delivered January 10, 1976, pp. 4 and 22-23.

individual federal bureaucrat is in no position to ask that question systematically. The problem needs institutional attention. Unless we can find ways to maintain the integrity of the federal grant, it will, like the DOD plane which was continually modified to accommodate new technical needs to the point it was too heavy to fly, become a cumbersome anachronism. That could have unfortunate effects on non-federal responsibilities in our federal system.

I'd like to give a concrete example of the concepts and problems that we've been discussing. In the National Science Foundation we have tried to maintain the integrity of the traditional research grant in which the grantee is responsible for performance in keeping with minimum federal standards. Our grants include standards such as the appropriate cost principles plus routine approval requirements for items such as foreign travel and equipment purchases.

Recently a member of Congress questioned proposed consultant fee payments in some NSF grant awards. As I noted, NSF grants contain the same type of cost principles or standards on the reasonableness of costs, including consultant service costs, that are contained in NSF and other government contracts. However, NSF does not include a requirement for prior review and approval of consultant fees in its grants.

What should our grant practice be? To defend ourselves from criticism we can require prior approval of consultant fees over a specified dollar amount in grants as we do in contracts. Should we do that?

That question forces us to face the question of whether we have a viable alternative to continually increasing the number of approvals required on our grants? What alternative do we have to becoming more involved in all grants?

We can operate on the basis that the NSF grant relationship requires that the grantee assume responsibility for performance of the work contemplated in keeping with minimum federal standards requiring only after-the-fact financial, programmatic or administrative reviews. Thus, we can say with respect to consultant fees, for example, that we have established a clear grant requirement and are holding grantees to it without operational involvement. This alternative places reliance on grantee systems and requires an effective Federal program of reviewing grantee systems and assisting in improving them.

A second alternative would be to formally delegate responsiblity for such decisions to grantees. A specific grantee institutional representative could be held accountable for the soundness and reasonableness of such decisions. That would be consistent with the devolvement of federal authority concept of the New Federalism which is still espoused by the present administration and is likely to be espoused by the next.

A third way of simplifying grant relationships would be to eliminate during performance approvals by prohibiting expenditures for some items in excess of amounts originally proposed, requiring an amendment to the grant in the unusual cases in which changes in these items or the work scope itself are required during performance. Again, such an approach would be consistent with the New Federalism as well as the statements of the President-elect that we must reduce federal red tape on grants.

An articulation of the implications of the foregoing types of alternatives would give us a more defensible grant philosophy than we now have. They would offer means of resisting or controlling the federal involvement or intervention that threatens the traditional grant. The traditional grant is an important alternative which provides balance in our federal system by permitting federal assistance without active project by project federal involvement or intervention.

A more effective institutionalization or recognition of the traditional grant relationship is important in establishing and maintaining a framework of basic relationships consistent with the intended balance in our federal system. By restoring the integrity of the grant we can stop the erosion of the grant; stop the proliferation of requirements on grants; and enhance grantee responsibilities. We can also force answers to questions as to when we should use procurement contracts; when we should use some variation of procurement contracts for control of assistance projects; and when we should use other types of agreements for the projects or activities requiring forms of active federal/non-federal partnership in accomplishing assistance objectives established by the Congress. By establishing reasonably clear definitions of alternative types of federal/non-federal relationships or interactions in terms of who does what and why we will have provided a basis for elaborating and clarifying federal accountability and making federal involvement and intervention more rational, and thereby, presumably, more acceptable.

Those who argue that because the federal departments and agencies are accountable for the expenditure of public funds in assistance programs, they must actively assure that those funds are spent effectively,* beg the question of what federal responsibility should be. They are able to do so without effective rebuttal because no clear viable alternative to federal intervention is being articulated. That does not mean that there is no viable alternative. The philosophy of federal procurement is clear. It rests on ultimate federal control of the acceptability of a product or result. The philosophy of federal grants or transfer payments was clear. But that philosophy has been

* See Thomas J. Madden, "Providing an Adequate Remedy for Disappointed Contractors Under Federal Grants-in-Aid to States and Units of Local Government," Federal Bar Journal, Vol. 34 (1975), pp. 201-228.

compromised by the use of grants for purposes requiring federal involvement or intervention. It has also been compromised by the accompanying tendency to treat grant relationships as being the same or very similar to procurement relationships. For example, the various public policy provisions are applied to grants as to procurement contracts without much, if any, consideration of how they will affect the basic grant relationship.

We need to state or restate our grant philosophy.

We need research on a multitude of related questions. Can we define "accountability" differentially? What does the trend toward being substantially involved in grantee contracting mean? What institutional changes should be made to recognize the differences between procurement and assistance, between contracts and grants? Which procurement techniques can be used in grant situations? How do we build grantee capacity and what is the federal role in doing that? What should the role of the Office of Federal Procurement Policy in OMB be in federal grant relationships? What changes or reforms are needed to assure effective management of grant programs? Research on questions such as these is important. It is important because answers to these questions will define federal and non-federal roles in our federal system.

9/28/76

ABSTRACT

TITLE: A New Look at PALT Management, a Continuing Procurement Problem.

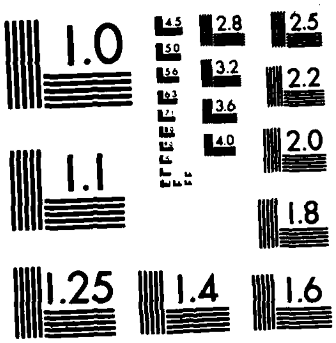
AUTHORS: Kimrey D. Newlin & Edwart T. Lovett.

Over the years there has been one continuous problem that has received much procurement emphasis; i.e., Procurement Administrative Lead Time (PALT). PALT has generally been viewed as being one of the primary causes of failure to meet the users required delivery date. Consequently, previous research on PALT has concerned itself almost exclusively with how to reduce PALT rather than how to better manage PALT. Also, in recent years, procurement managers have complained that the constant emphasis on reducing PALT has limited their options considerably and that a new, more modern management approach is required for PALT. The Army Procurement Research Office (APRO) at Fort Lee, Virginia, recently undertook a study to re-examine the traditional ideas about PALT as well as current reality in order to develop more appropriate PALT management and performance criteria. The specific objectives of this project were to: analyze an Army Command's current system for managing PALT, determine meaningful PALT objectives as an aid in managing PALT, and establish PALT management and performance criteria for use by procurement managers.

Traditional research methods were employed which consisted of reviewing publications and ongoing research on PALT as well as interviewing key procurement management officials at an Army HQ Command and its Major Subordinate Commands (MSCs). Additionally, a more modern, scientific method was used in this study which applied quantitative techniques to the management of PALT. This scientific approach specifically included the collection of fiscal year 1975 PALT data which was used to compare the consistency of the Command's current PALT standards to actual field experience. A test of hypothesis and a one-way analysis of variance (ANOVA) were performed to determine if PALT was significantly different for the various procurement breakouts between the MSCs. A frequency distribution of the predominant reasons for PALT delay was established for the different methods of procurement. Also, this approach included the analysis of PALT data from the Logistics Performance Measurement and Evaluation System (LPMES) to identify the phases of the pre-award procurement cycle that requires the greatest percentage of PALT in order to inform procurement managers where emphasis, in order of priority, should be placed. This approach also included the principle of experimental design which was used to establish a valid data collection plan for PALT data which could then be analyzed by utilizing statistical methods (parametric and non-parametric) and operations research methods to develop PALT management and performance criteria.

AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76 3/7

UNCLASSIFIED F/G 15/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ABSTRACT

TITLE: A New Look at PALT Management, a Continuing Procurement Problem.

AUTHORS: Kimrey D. Newlin & Edwart T. Lovett.

Over the years there has been one continuous problem that has received much procurement emphasis; i.e., Procurement Administrative Lead Time (PALT). PALT has generally been viewed as being one of the primary causes of failure to meet the users required delivery date. Consequently, previous research on PALT has concerned itself almost exclusively with how to reduce PALT rather than how to better manage PALT. Also, in recent years, procurement managers have complained that the constant emphasis on reducing PALT has limited their options considerably and that a new, more modern management approach is required for PALT. The Army Procurement Research Office (APRO) at Fort Lee, Virginia, recently undertook a study to re-examine the traditional ideas about PALT as well as current reality in order to develop more appropriate PALT management and performance criteria. The specific objectives of this project were to: analyze an Army Command's current system for managing PALT, determine meaningful PALT objectives as an aid in managing PALT, and establish PALT management and performance criteria for use by procurement managers.

Traditional research methods were employed which consisted of reviewing publications and ongoing research on PALT as well as interviewing key procurement management officials at an Army HQ Command and its Major Subordinate Commands (MSCs). Additionally, a more modern, scientific method was used in this study which applied quantitative techniques to the management of PALT. This scientific approach specifically included the collection of fiscal year 1975 PALT data which was used to compare the consistency of the Command's current PALT standards to actual field experience. A test of hypothesis and a one-way analysis of variance (ANOVA) were performed to determine if PALT was significantly different for the various procurement breakouts between the MSCs. A frequency distribution of the predominant reasons for PALT delay was established for the different methods of procurement. Also, this approach included the analysis of PALT data from the Logistics Performance Measurement and Evaluation System (LPMES) to identify the phases of the pre-award procurement cycle that requires the greatest percentage of PALT in order to inform procurement managers where emphasis, in order of priority, should be placed. This approach also included the principle of experimental design which was used to establish a valid data collection plan for PALT data which could then be analyzed by utilizing statistical methods (parametric and non-parametric) and operations research methods to develop PALT management and performance criteria.

dnil 2...

THE CONCLUSIONS WERE:

1. The establishment of valid PALT standards is a useful and necessary management technique which will encourage award of PWDs in a timely manner provided that performance is evaluated on a regular basis.

2. The PALT delay codes are essential to good PALT management. The most frequent reasons for PALT delay are in fact of equal, if not greater, importance than the PALT standards themselves, in that the delay codes identify bottlenecks which, if corrected, would minimize PALT.

3. The current definition of PALT needs to be expanded to include the HQ management information system methods of generating and tracking PWDs.

4. Procurement managers would derive great benefits from employing statistical methodology to develop future PALT standards and evaluate performance against those standards.

5. PALT is statistically significantly different at each MSC and between methods of procurement (Formal Advertising vs Negotiation).

6. PALT is not statistically significantly different for fixed price contracts as opposed to cost reimbursement contracts. Nor is PALT significantly different between the three dollar stratifications tested.

7. In view of the increase in the number of two-step formally advertised contracts from fiscal year 1975 to fiscal year 1976, it is considered appropriate for the present to keep the current PALT standard for two-step formally advertised contracts.

8. Certain segments of PALT account for varying portions of time during the pre-award procurement cycle depending on whether the procurement is formally advertised or negotiated. For formally advertised procurements, the pre-solicitation and solicitation phases account, on the average, for approximately 50 percent of the total PALT. For negotiated procurements, the solicitation and evaluation/analysis phases account for slightly more than 50 percent of the total PALT.

9. The major portion of PALT management should be concentrated on PWD's over $10,000, although PWD's under $10,000 accounted for 78 percent of the total PWD's processed in FY 75, only 33 percent of the manpower was devoted to these PWD's. They also accounted for only approximately 2 percent of the total dollars awarded in FY 75.

THE RECOMMENDATIONS ARE:

1. The use of PALT standards should be continued throughout the Command.

2. Although PALT performance is reported on a monthly basis, the MSC's PALT achievement towards meeting the PALT standards should be assessed only on a quarterly basis due to the inherently large standard deviation in PALT.

3. PALT standards should be reviewed and updated every year, based on actual performance during the previous 12 months. This is feasible with computer management information systems.

4. PALT performance should be displayed so as to show trends both within the fiscal year and among fiscal years. When PALT performance is felt to be at a level consistent with good business practices, the emphasis on PALT should be reduced.

5. A detailed analysis of the PALT delay codes should be conducted quarterly. Appropriate action should be taken to reduce or eliminate the most frequent reasons for PALT delay.

6. PALT regulations should be updated to provide an expanded PALT definition which should incorporate the capabilities of the PALT management information system.

7. Procurement managers should consider utilizing the statistical methodology employed in this report as the method for developing future PALT standards and evaluating performance against the standards. The best way of implementing this methodology is to initiate a system change request to the existing PALT management information system delineating the additional uses of the data generated. The specific statistical methods which proved most useful were frequency distribution, test of hypothesis, and analysis of variance.

8. Separate PALT standards for Formal Advertised and Negotiated PWDs should be established for each MSC.

9. The current PALT standards for two-step formally advertised contracts should be kept until the upward trend in the use of two-step IFBs from fiscal year 1975 to fiscal year 1976 can be assessed. If this upward trend does not continue, the need for a separate standard should be reassessed.

10. Procurement managers should concentrate their attention on those segments of the pre-award procurement cycle which account for the largest portion of PALT.

11. Procurement managers should concentrate their attention on those PWDs where the bulk of the manpower and dollars are devoted, above $10,000. However, the procurement manager must remember his responsibility for the successful completion of the overall program.

ABSTRACT

CONSOLIDATED GOVERNMENT PURCHASE OF RAW MATERIAL

United States Air Force
Reserve

Aeronautical Systems Division/XOR

Project Number 75-9

by

Lt Col David C. Stone
Lt Col Martin M. Waxman
Capt Jan C. Berlage
Capt David K. Foote

15 May 1976

New York Flight/ Washington Section

Proposed ASD Reserve Project

INVESTIGATION TO DETERMINE THE FEASIBILITY OF USING GOVERNMENT FURNISHED RAW MATERIALS AND PARTS

Description of Project

Almost all contractors doing business with the Government purchase raw material and common items individually which are used in manufacturing equipment that is sold to the U. S. Government. By purchasing these raw materials and common items in small quantities the price per item cost more than if the items were purchased in large quantities. There are also the costs of the buyer's time, paper work, storage, etc., which should be considered in the cost of the equipment that the U.S. Government purchases. It has been suggested that a study be made comparing the cost of some of the more widely used raw materials and common items as purchased by contractors with the cost of the Government purchasing and providing these same items for the contractors in larger quantities.

The tasks required to accomplish this project are listed below:

1) Study how present purchases are made by contractors, frequency of purchase and size of purchase.

2) Determine advantages and disadvantages of the current method.

3) Determine how Government would purchase material: A) Order and stock material in warehouse; B) Order direct from supplier direct to contractor.

4) Determine pros and cons of each alternative.

5) Research and understand functions of agencies that currently supply material to contractors. Note the pros and cons of this activity.

6) Research where prime contractors supply to sub-contractors.

7) Study side effects of the Government supplying material to contractors

in terms of: A) effect on industry; B) legal aspect; C) economic impact on community and industry; D) area of responsibility regarding late deliveries; E) disposal of obsolete material ordered by the Government; and F) administration costs to run the program.

Objectives

1. To determine and list advantages of consolidated government purchase of certain raw materials for Air Force wide use.

2. To determine and list disadvantages of consolidated government purchase of certain raw material for Air Force wide use.

3. To compare the advantages and disadvantages of large government purchase of certain raw materials, and if a positive recommendation is made made, list the materials which would best lend themselves to the approach.

4. Familiarize the ASD reserve team members to the approach.

Statement of the Problem

How can raw material purchases be consolidated so as to be advantageous to the Government?

Factors Bearing on the Problem

Facts:

a. Costs of Military hardware and systems are rising.

b. Small quantity purchase prices are greater than large quantity purchase prices.

c. The classic method of reducing the number of small orders written is to consolidate small orders into large orders.

d. Contractors doing business with the U.S. Government purchase the same or similar types of raw materials and common items on an individual basis. This material is then used in manufacturing items sold to the Government.

Assumptions:

a. By purchasing raw materials and common items in small quantities, the per item cost of the finished products is more than if the raw material were purchased in large quantity. (See Facts b and d).

b. Cost to the Government could be reduced if some central organization in the Government would anticipate requirements for certain basic materials and consolidate small requirement orders into large volume purchases. (See Facts a and c).

c. The Government purchased volume raw materials, could be either distributed by the Government or the suppliers. Several schemes for the distribution are discussed in this report.

d. Sheet metal and bar stock are reasonable raw material candidates for study and test program implementation.

e. The Government has been supplying items to contractors for many years in the form of Government Furnished Equipment (GFE), with no contractor reimbursement of funds to the Government agency.

Definitions:

For the purposes of this study, raw materials shall mean metals such as steel and aluminum that comes in sheets or bar stock.

Conclusion

It is the recommendation of this study, that approach number 5, as outlined below, is the most reasonable approach for the Government to take in its purchase of raw materials and common items.

Approaches #1 through #4 were rejected because they involved traditional methods that meant considerable costs for the Government.

Rejected Approaches

Discussion

This section discusses the rejected four possible solutions to the problem. It presents the requirements of each one, describes its operation in outline form, and presents pros and cons.

Approach #1:

Government supplies materials from a Government Warehouse, to small business Government contractors.

1. Requirements:

   a. Obtain Warehouse.

   b. Set up staff and establish procedures.

   c. Determine material, type and quantity to be stocked, and the average inventory requirements.

   d. Order material in economic quantities.

2. Operation:

   a. Material delivered from mill or suppliers/distributors to warehouse, and receiving report made up.

   b. Receiving inspectors inspect material.

   c. Convene a Material Review Board on rejected material disposition.

   d. Stock the material.

   e. Maintain inventory records and control.

   f. Process contractor orders to release material.

   g. Send material from storage areas or bins to shipping.

   h. Inspect the material.

   i. Package the material for shipment

j. Traffic arranges for shipment of the order.

k. Process any invoices, damage claims, etc.

l. Reorder new material to replenish stock.

3. Pros:

a. Material is readily available when required for delivery to contractor.

b. Lower cost to Government in ordering lot or carload quantities for best price advantage.

4. Cons:

a. Cost of operating a warehouse is high. Overhead is estimated at 18-25% of material costs. One warehouse estimates, verbally, that storage/warehouse costs are $5 per ton per month. These estimates were given by suppliers who order, stock, and resell aluminum and steel.

b. Responsibility of Government for supplying material on time to avoid production delays by contractors.

c. Competition with local suppliers might have anti-trust implications. The Government would be acting as its own supplier in both buying and selling. This may be forbidden by statute.

d. The Government would be typing up money in intermediate goods inventory, at approximately a 10% interest rate.

e. Storage costs on metals are high -- see 4A above.

f. Obsolescence. Material on hand can become obsolete due to specification, engineering, and technological changes.

g. Because of the diversity of Government contracts, there is a great administrative problem in knowing what to stock as far as quantity and type are concerned, and in determining frequency of use and reorder points.

h. There is a problem in determining warehouse location for minimizing shipping distances and shipping costs related to distance. Diversity of contract fulfillment locations intesifies this problem.

i. Loss of taxes private industry would pay if the Government took over supplying material.

5. Responsibility:

a. Government is responsible for the material.

b. There are possible legal problems with the Government responsible for loss of business to private industry, and responsible for possible anti-trust behavior.

c. The vendor/contractor is responsible for the type and quantity of material ordered.

d. The Government is responsible for controls and audits to assure there are no abuses in the system.

Approach #2:

The Government would supply the material as Government Furnished Material (GFM).

1. Requirements:

The requirements would essentially be the same as those for approach number one. However, they would not bill the contractor for any material he would order in fulfillment of the contract. Operation, and pros and cons would also be essentially the same, except that the Government would

would furnish the material as GFM.

1. Responsibility:

The Government assumes full responsibility for stocking the type and quantities of materials needed to fulfill the contractors requirements.

Approach #3:

In this approach to solving the problem, the Government would supply material to Big Business Prime contractors. Again, this approach is similar to Approach #1 in that it would involve several or many large warehouses.

1. Pros:

Since the Government is supplying material for prime contractors, they would be getting the best price for large quantity purchases.

2. Cons:

This would again be the same as Approach #1, except that the Government would be typing up production of mills and competing with industry.

An additional problem would be that of ordering and scheduling very large shipments for the Prime Contractors. Prime contractors would most likely order at the same price quantity as the Government.

Approach #4:

1. Requirements:

The Government would set up requirements contracts for all industry prime contractors and small business as throughout the U.S., by obtaining bids from raw material suppliers on an annual basis. The contract would require the mill or supplier to ship on as as required basis to contractor locations.

2. <u>Operations</u>:

a. Locate bidders that can handle very large Government orders.

b. Set up an ordering staff.

c. The contractor would order material as required, and would pay the mill or warehouse at the pre-established contract price.

3. <u>Pros</u>:

a. The Government would obtain the best price on material through quantity purchases.

b. The Government would avoid small order costs.

c. The Government would not be responsible for storage, inspection, or shipment of material.

d. Material would be available when required by the contracts.

4. <u>Cons</u>:

a. It might be difficult to find a mill that would be willing to handle or fill orders of this size, or have readily available stock on hand in the required quantity.

b. It might prove difficult to obtain bidders since there are a limited number of suppliers for very large orders.

c. Long distances between the mill and the supplier would add transportation charges that would cancel a portion of the quantity/price advantages obtained.

d. The Government would compete with industry by bypassing certain portions of the market channels of distribution.

e. The Government would have responsibilities if the mills or suppliers failed to deliver mate ial on time to contractors.

5. Responsibility:

a. The Government is responsible for seeing to it that the contractor gets the material required from the supplier.

b. The contractor is responsible for ordering his material from the supplier.

c. The mill or supplier has the responsibility for stocking and delivering the material to the contractors.

Approach #5:

In this approach, the Government would set up many requirements contracts throughout the U.S. Each one covering a small regional area.

1. Requirements:

On an annual basis, send out bids and make an award to suppliers in various regions of the U.S.

2. Operation:

a. Contractor orders material from the selected distributor or supplier and pays for the material at the contract rate.

b. The distributor or supplier ships the raw material quantity ordered by the contractor, and bills at the volume discount rate.

3. Pros:

a. The raw material price is the best large quantity price available. This can result in large savings.

b. Small order charges by distributors or suppliers are avoided.

c. There is a savings to the Government on the cost of contracts with suppliers or distributors.

d. The regional contracts would avoid long shipping distances for the material.

e. The regional contract would help insure delivery of the raw material within specified time limits.

f. The Government does not use its funds to either purchase raw material or to warehouse the raw material.

4. Cons:

a. The contractors choice of suppliers or distributors is limited -- to the sole source.

b. The approach limits the number of suppliers or distributors that will get Government or contractor business.

c. Distributor or supplier failure to deliver or failure to make timely delivery would make the Government responsible for contractor to meet schedule dates.

d. There might be a real problem in locating suppliers in a given geographic area that would accept a Government requirements contract.

e. Default of a supplier or a distributor might severely affect contractor time schedules.

f. The Government must make annual projections on raw material usage for the annual bidding procedure.

5. Responsibility:

a. The contractor is responsible for inspection, rejection, quantity, and order lead time for raw material.

b. The Government is responsible for performing audits to prevent abuses of the system such as ordering for non-Airforce work or ordering for commercial work.

c. The supplier or distributor is responsible for supplying raw material of the type and quantity ordered by the contractors, on time, and at the quantity discount price.

Discussion

The outline of approach number 5 in the previous section only reveals the barest essentials of the concept. The contract written, would require the supplier or distributor to furnish materials or supplies to contractors, in small quantities, at a contracted for, large order quantity price.

Further, <u>the recommendation calls for the contractor and the supplier or distributor to deal directly with each other</u>. <u>This is the part of the recommendation that is an entirely new procurement method for the Federal Government and its agencies</u>. It is, however, not so new that it has never been tried before. There are functioning precedents that can be examined as working pilot models that must be translated to the scale of the Federal Government.

The Purchasing Department of the City of New York writes requirements contracts of the type that we are recommending for the Federal Government. And, the City of New York does benefit from savings inherent in the scheme. They have proved that at this scale, the system works. They do not have funds tied up in material inventory; they do not have the expenses of warehousing such as clerks, inspectors, inventory control, shipping, receiving, traffic, space allocation, reorder, etc. They do not have an expensive bureaucratic structure that must be traversed to get the material to the contractor.

Armed Services Procurement Regulations (ASPR), have been reviewed. ASPR Appendix H: Military Standard Requisitioning and Issue Procedure, reveals, that the Government has defined and conceived almost every possible purchasing relationship except the contractor to contractor relationship.

The one Basic Ordering Agreement that probably comes closest to our recommendation is that of the Sandia Laboratories Purchasing Instruction. The big difference is that in our recommendation, an Authorized Ordering REpresentative or Agent is not a link or control point in the procurement chain of events. The contractor in our scheme would deal directly with the regional supplier, with whom one of these new requirements contracts has been written, ordering against a contract number.

In addition to stressing the contractor to contractor concept, we feel that the concept of many contracts with local or regional suppliers or distributors needs further emphasis and clarification. There are two main reasons for aspect of our concept, and both have economic roots. First, it is our opinion that locality or regionality will avoid the economic and market problems traditionally tied to sole source purchasing, and allow the market place to function normally and help maintain, establish and foster competition. Second, Transportation costs are a major part of total bid price on any material. Generally, the greater the distance from the source of the material to the user of the material, the greater is the cost of the material. In any event, transportation costs will affect pricing, and, therefore, we might assume that material purchased from local or regional suppliers would be less costly than material from suppliers further away. Along this line, it is of interest to note that New York State pays a higher price than does the City of New York for many items purchased on yearly requirements contracts. This is because suppliers contracting with New York City have much shorter delivery distances and fewer delivery focal points than do the New York State suppliers. The New York City purchasing experience reveals that many outlying suppliers do not bid because they cannot compete with local suppliers due to transportation expenses in relation to their size.

Further Actions REcommended

We realize that our recommendation requires some further study in preparation for any implementation of this new type of procurement contract. Below, we suggest further study areas.

Item Analysis

1. Can the Government determine or project its own requirements? Studies must be carried out to determine order quantities based on demand forecasts.

2. Can Government procurement personnel determine a range of raw material or common item candidates for this new type of contract? Commodity studies will have to be made.

Administrative Problems

1. At this incipient analysis stage, many of the scheme's administrative problems are, of course, unknown. It is assumed that there will be a concerted effort to minimize bureaucracy, and that the plan will be no more difficult to administer than any other procurement function -- in concept, it should be easier to administer.

Legal Matters

Government legal personnel will have to work out the procedural and contractual language related to the new contract. Some of these are listed below, and we feel sure that the legal staff would be able to recommend points we have not thought of.

1. Contract periods of performance.

2. Geographic areas of contract responsibility.

3. Periodic audit and surveillance of the system for control and to prevent abuses such as the ordering and use of material on civilian work.

4. Billing and the handling of payments.

5. Disposition agreements for material not used by contractors, or obsolete items.

6. Disposition agreements for material ordered from the suppliers under the government purchase, and not requisitioned by contractors by the end of the contract period.

7. Cost escalation of price-in-effect at time of shipment, are common contract clauses in these time of volatile commodity and material prices. They should be carefully prepared.

8. Since the intent of the newly recommended government purchase procedure is not to completely tie the hands of a contractor in acquiring material to perform a contract, there must be contractual provision for equitable contract adjustment and a controlled means of going to a new or contingency source or means of buying elsewhere, should there be unusual delivery performance problems or non-delivery problems, or known delay problems of any sort. This does not defeat the plan, but sensibley provides for a means of performance in the even of unforseen problems.

A METHODOLOGY FOR ESTIMATING JET ENGINE COSTS EARLY IN WEAPON SYSTEM ACQUISITION

BY

Michael A. Yanke, Capt, USAF
Procurement Research Officer
Air Force Contract Management Division
Directorate of Management Services
(AFCMD/XRR) Kirtland AFB, NM 87115

Abstract

Accurate cost estimation has been elusive to Department of Defense (DOD) management. Numerous reports and comments from senior DOD officials indicate a dissatisfaction with cost overruns, particularly those associated with inadequate cost estimates early in the acquisition process. In engine acquisition, the F-100 engine is a current example of an inaccurate early cost estimate.

Cost estimation can be divided into two general categories: Engineering/Accounting and Statistical/Parametric. Accounting estimates require large amounts of data and consume both time and manpower. This type estimation has its place in the acquisition process. Accounting estimates can be used effectively in the full scale development phase when the needed data is available. Statistical/Parametric estimates require limited data that can be defined early in the acquisition process. Specific design characteristics can be used as independent variables in the estimating model. The current Air Force parametric model was developed by Rand Corp. It is a two variable exponential model. The Navy cost model is a three variable linear model. The basis of the Navy model is the Maurer Factor. The Maurer Factor considers materials, input parameters, as well as engine design characteristics. The innovation is consideration of an input parameter as a possible cost driver.

The objectives of the proposed methodology are: to provide a model with increased predictive capability; that is, a model which can be used with statistical confidence to provide predictions whose accuracy can be viewed by the user with confidence; and to determine if materials variables should be included in future cost estimating models.

A data base was established from verifiable sources. Independent variables (21 for materials models, 18 for nonmaterials models) came from official Air Force sources, such as the Gray book, and contractor supplied information. Cost data came from the Gray book and was verified through Price Negotiating Memoranda. Costs were adjusted to constant year dollars using indices available in Air Force Regulation 173-10. Models were developed using engines with materials data and without materials data. The procedure was the same for both. The data base was randomly divided into two parts: a build group with eighty percent of the data and a test group with the remaining twenty percent. Prior to the construction of the model, a level of significance is set for the individual independent variables and the model as a whole. No independent variable is kept in the model unless it is statistically significant. The model is developed from the build group data. The test group data are used to test predictive capability. Predictive capability is a subjective look at the model predictions. The user must specify a range of values, a prediction tolerance, and determine how many times he can allow the predictions to fall outside this range and still consider the model a useful predictor. The utility of application is determined by a subjective look at the confidence intervals about the predictions. The user must determine whether or not a model can be tolerated whose confidence interval is the prediction plus or minus a given dollar value. The relationship of the width of the confidence level to the value of the prediction is the determining factor. The basis for acceptance of the model, then, becomes the width of the confidence interval and not solely an R^2 or F-statistic.

The technique produced a nonmaterials model with an increased predictive capability and a higher utility of application to the user than models currently employed by the Air Force. Sample sizes have proved to be extremely important. While small sample sizes can produce models with high R^2 values and an acceptable F-ratio, the predictive capability of the model and its utility of application may be questionable. Independent variables must be statistically significant at a pre-specified level to preclude decision making on acceptance of a variable when the value of the prediction is being examined. Grouped data, especially when changes in technology occur, impact the independent variable. The materials variables produced statistically valid models but the sample size must be increased before the utility of application can be realistically evaluated. The reason for a small sample is the source of the materials variables, the DD 346, Summary Bill of Materials, is a not exercised optional contractual requirement.

Engineers must become involved in cost estimation early in the acquisition of a weapon system. The variables should be specified, the data base should be collected, and the models should be built by the engineers. Before the materials variables are brought into cost models the classification and weighting factors used in the Maurer Factor should be re-evaluated. The classifications have gone unchanged since the inception of the Maurer Factor concept in 1967. Using the Maurer Factor and the presented methodology as a beginning, there is a basis for joint service cost estimation. Pooled information and a joint effort may eliminate the requirement for nonDOD contracted research. The methodology presented here is most important. The concepts of predictive capability and utility of application play an important part in the acceptance of a model. A model should predict at a satisfactory level to be useful.

An Analysis of Competitive Bidding
on BART Contracts

Kenneth M. Gaver

Jerold L. Zimmerman

November, 1975

Graduate School of Management
University of Rochester

(716) 275-4896
(716) 275-3397

ABSTRACT

This study analyzes the competitive bidding on the heavy construction projects of the San Francisco Bay Area Rapid Transit (BART) District. An analytical model is developed for the study of the BART bidding experience, and is then used to derive a number of propositions concerning the bidding behavior of the participating contractors. Data pertaining to 77 BART construction projects, is used to test statistically the dervied propositions.

Our results showed that of the six propositions set forth, none could be rejected. These findings are summarized as follows:

1. As the joint venture's outstanding BART work increases, subsequent bids are raised.

Even though a complete record of each bidders existing work is not available, bidder's with more in-process BART work bid higher than those with less in-process BART work which suggests an upward sloping average cost curve.

2. Ceteris paribus, larger construction firms (including joint ventures) tend to submit lower bids than smaller firms or joint ventures.

In this case where the bidder is a single firm, this phenomenon may stem from certain economies of scale due to vertical integration of skills within the firm. Where joint ventures are involved, the syndicate's size is directly related to the number of firms comprising the venture. It is certainly plausible that a primary reason for forming joint ventures is to pool contractor specializations, and thereby achieve similar advantages enjoyed by the large, vertically integrated firm.

3. Holding project size and complexity constant, the longer a contractor has to complete the project, the lower his bid.

On the longer contracts, there were greater opportunities for cost reductions, which were shared between the contractor and the District. Furthermore, longer contracts provided more chances to share certain fixed costs (start-up costs or transaction costs). Had BART not provided the contractor with a high progress payment rate, then this finding may have been reversed to the extent the contractor had his capital tied up in the project.

4. The greater the number of firms in the joint venture submitting the bid, ceteris paribus, the lower the bid price.

The syndication process in the construction industry is not well understood. For example, what are the contractual and economic differences between syndication versus sub-contracting and why does one of these forms predominate in specific contexts? However, we can hypothesize that prior to bidding, firms choose the optimum size of the syndicate. We assume that the syndicate will admit a new member if for all members in the syndicate the benefits (risk and bond sharing and an increased chance of winning by submitting a lower bid due to a cost savings unique to the new member) outweighs the costs (the additional control and coordination costs). This analysis suggests then that joint venture size is inversely related to bid. Moreover, this relationship should be stronger on larger constracts where there is more opportunities for the syndication process to produce benefits.

5. Bid prices are reduced as the number of bidders on the project is increased.

Due to the information available to the bidders prior to bid submission, each bidder was assumed to have formed an unbiased estimate of not only the number but also the identities of his competition. As the extent of the bidder's competition rises, (i.e., there is an increase in the number of bidders) he revises his chances of winning (the hazard rate) and he tends to lower his bid such that at the margin, the decreased chance of winning due to an increase in competition is offset by an increased chance of winning by shaving his bid. However, this analysis ignores the more basic question of what factors cause six contractors to bid on one project and only three on another contract?

(1) The enclosed paper is 25 pages in length.

(2) Presentation time can vary from 15-45 minutes.

(3) An overhead transparency project would aid the presentation.

(4) This contributed paper would be most appropriate under the competition session.

PROCEEDINGS

LISTING OF PAPERS
BY SESSION / WORKING GROUP

LISTING OF PAPERS (cont'd)

WORKING GROUP D (cont'd)

WORKING GROUP E

RELIABILITY & MAINTAINABILITY ISSUES

WORKING GROUP F

SOCIO-ECONOMIC IMPACTS ON PROCUREMENT

GENERAL SESSION II

RECONCILING ORGANIZATIONAL INTEREST IN PROCUREMENT RESEARCH

No Papers Submitted

GENERAL SESSION III

ACQUISITION STRATEGY PLANNING

No Papers Submitted

LISTING OF PAPERS (cont'd)

WORKING GROUP G

MAJOR SHIPBUILDING SYSTEMS

THE "REAL WORLD" AND PROCUREMENT RESEARCH

ROBERT R. JUDSON
Adjunct Professor
Systems Acquisition Management
U.S. Naval Postgraduate School

Abstract

The basis for committing scarce and costly procurement research activities dealing with major systems issues is identified.

Without denying the "reality" of what an individual researcher may observe, the paper challenges the traditional horizons of the "real world" for major systems as being an arbitrary limit that degrades research products.

A plea is made to expand the limits of the "real world" to include the entire acquisition process.

PROCUREMENT AND ACQUISITION DISTINGUISHED

To identify the potential contribution, as well as the problems related to conducting procurement research, it is necessary to identify the point in time when various management responsibilities are understood to be involved in what may be called the "acquisition process." It should be the objective of procurement research to serve the needs of these various management responsibilities.

"Procurement activities" have, by custom and usage, most often been defined as those activities which take place <u>after</u> funds are joined with a specific procurement request. This is a perfectly acceptable identification of the point in time when "procurement management" considerations should enter the picture <u>if</u> the product involved is of mature design, with significant cost precedence and where the procurement may be conducted utilizing real competition.

This same "point in time" for the initiation of "procurement management" responsibilities does <u>not</u> serve well if we are dealing with complex systems acquisitions involving high-technology products, those systems whose interrelated parts draw on new technology and whose high costs warrant special management attention, systems which are characteristic of both defense and civil agencies.

My comments on research assume this sophisticated system example. Therefore, we talk about research related to managing the <u>entire</u> "acquisition process," not just those time-limited events which we have grown accustomed to calling "procurement activities."

ENVIRONMENT FOR THE CONDUCT OF RESEARCH

If we are to be successful in research addressing operating-level problems involved in the production and administration of complex systems, we must understand the environment in which acquisition events take place. I would like to suggest three aspects of this environment which operate at three very different levels of acquisition concerns. They are:

1. The emergence of a "contract state," the central feature of modern governments, wherein the authority of the government is shared with private institutions in meeting national needs.

2. The natural consequence of the way our government is organized, with powers shared between legislative and executive functions.

3. The way we now conceptualize procurement problems and institutionalize the effort to seek answers to procurement management problems through research.

The extent and novelty of the private sector performing governmental responsibilities in the United States is only a phenomenon of post-World War II history. By now, however, the sharing of tasks between the formal machinery of government and other institutions in society is so routine that we take it for granted.

Government is expected to stimulate balanced economic development, curb environmental abuses, promote health, education and scientific progress, assimilate underprivileged groups into the mainstream of social life, ad infinitum. In short, government is expected to undertake activities of an unprecedented complexity and magnitude. These heightened expectations of "consumer politics" have been pursued without the benefit of a well-formulated economic theory to guide the management of the relationship between government and its reliance on some version of what we may call the "private sector." In the United States, the contract arrangement or grant variant thereof has been the principal device through which the government accomplishes the public business.

The government's dependence upon the private sector, <u>absent</u> a well-formulated economic theory, has created a classic confrontation between the need for "public accountability" and the need for "private independence." The basic question, which so many entities in government seek to answer regarding management of the acquisition process is, "How can the government intervene on behalf of the public interest to achieve accountability?" The companion question, which also must be answered, is, "How can this intervention take place without eroding the autonomy and essential vitality of society's private sector?" In the attempt to answer these questions, government officials have never used--indeed, have never had--a comprehensive framework of thought for viewing such issues, or anything like a systematic way to evaluate the effectiveness of a particular procurement management technique to procurement policy or, more importantly, the cumulative impact of dozens of procurement management techniques or procurement policies originating from many different governmental entities.

Given the complexities of the "contract state," if we can't establish a responsible management focus to deal with the total implications of acquisition management, then government may not be able to preserve the essential character of a private sector concept, or its equivalent, as government struggles to meet ever increasing and diverse demands for greater public accountability. To illustrate, in the United States the government has achieved a greater degree of de facto management control over the aerospace industry through the contract device than the British government has achieved by nationalizing certain industries. On the other hand, the intensity of "competition" among Soviet aerospace design activities approximates the tough, competitive approach to determining the best design that we would like to associate with a free enterprise economy. We have had little consensus or understanding of the economic implications of the contract state as we initiated our procurement research.

Another concern for the research environment is built into United States government institutions. We like to think of separation of powers when we consider the activities of legislative and executive functions, but the separation of these powers is blurred. What we have are separated institutions sharing powers. In the field of procurement, there is a rivalry between these two functions for control over certain aspects of the procurement process.

For example, we clearly have statutes that are regulatory in nature, such as those relating to the cost allowability of certain overhead items; on the other hand, we clearly have regulations with the force and effect of laws. Thus, the legislature may prescribe executive procedures, and executive functions may "legislate."

It is essential that acquisition research consider the realities of organizational issues impacting on the acquisition process.

Finally, absent an economic theory and given the shared powers of governmental institutions, there is yet a third important and operating-level concern in the environment surrounding the efforts to establish significant acquisition research. This concern derives directly from how we have elected to manage the acquisition process.

For administrative convenience, we have fractionalized the acquisition process so that it has become sequential, functionally "exclusive" subsets of activities, one of which is procurement. Through this fractionalization, the sum of the administrative parts is considerably less than a well-managed, coherent process.

It is a simple coincidence that the complex, major systems concerns of schedule slippage, performance shortfall, and cost growth occur in a time frame associated with our traditional definition of procurement responsibilities. Most typically, the origins of so-called "bad procurements" fall outside the time frame for procurement activities.

Research which is not premised on a cause and effect distinction, research which seeks to solve "bad procurements" within the time frame, and with the "tools" available, for what we have traditionally called the procurement function, will almost certainly be research addressed to symptoms of "bad procurements," not root causes. Most research addressing the problems of complex systems procurements falls into this trap.

Evidences of the trap are the succession of procurement fads, designed to alleviate procurement management problems. Thus, we have seen universal applications of incentive contracts, specified use of total package procurements, mandatory design-to-cost use, reliability improvement warranties, etc, etc, parade before us as products of "research" designed to solve complex procurement problems.

There is a double fault here. First, any one of these techniques has a validity for use in the proper circumstances and ought not to be banished forevermore when the fad passes and we still have our old problems. Second, the "procurement community" is at odds with itself to be able to conceive of relevant research undertakings.

Like an old prisoner who has served his time and is offered his freedom, the procurement function is more content to remain in prison with its confined vision than to enter the unknown world of the total acquisition process. We have institutionalized the procurement process in the way we manage it, to accept its own confinement as desirable. Problems to be solved, wherever they originate, are converted to the comfortable and familiar terminologies of the procurement function, thus virtually assuring that research will deal only with symptomatic problems. <u>Not</u> solving problems but rationalizing their legitimacy is the first order of a self-perpetuating bureaucracy.

This presentation makes a plea that, to assure the integrity of research products, we must:

1. Establish a contextual setting for research, which includes an appreciation for the theoretical, governmental, and organizational implications for the acquisition process.

2. Establish standards for assessing the validity of research candidates by viewing cause and effect relationships in a total acquisition context.

3. Establish standards for assessing the products of research, requiring that specific research products account for their impacts on other aspects of the acquisition process. In this way, we could evaluate how implementation would affect the total acquisition process.

PROCUREMENT INFORMATION

In viewing procurement research today, we find:

- There is no central management focus to evaluate research needs on a coordinated and continuing basis, although that seems to be implied in the charter of the congressionally established Office of Federal Procurement Policy, a function of the Executive Office of the President, and should be a feature of the Federal Procurement Institute.

- There is no "clearinghouse" organization to synthesize the concerns of the Congressional Commission on Government Procurement, General Accounting Office, congressional committees, or many of the executive branch or industry studies advocating or implying the need for research, although that should be a key characteristic of the emerging Federal Procurement Institute concept.

- There is no coherent data base of acquisition-related information which would constitute the essential "tools for research," although many ad hoc efforts reside in various executive and legislative organizations awaiting utilization by the Federal Procurement Institute.

We have no corporate memory about our efforts at procurement management, or what I hope I've convinced you to call acquisition management. We don't learn from ourselves or each other on a systematic basis as to what effective problem-solving techniques have been evolved or how to avoid the problems which command so much of our time and resources.

This conference and ones like it have a distinct value in bridging this information gap but cannot assume the total information burden.

The only professional-level efforts in this area of which I am aware are the activities of the National Contract Management Association (NCMA). NCMA activities include a professional journal, a monthly newsletter reporting on the acquisition scene, and a full range of meeting and symposia activities dealing with many facets of the acquisition process. Recently, this organization initiated certification procedures for testing the professional competence of managers dealing with aspects of the acquisition process.

Collectively, the Office of Federal Procurement Policy, the potentials of the Federal Procurement and the activities of the National Contract Management Association permit me to leave you on an optimistic note regarding the prospects for procurement information and its exchange.

CONCLUSION

Alchemy had as its chief objective the transmutation of base metals into gold. Historically, alchemy was part of a general striving for perfection. The alchemists were obsessed with their quest for transmutation. Some adopted deceptive methods of experimentation. Many gained a livelihood from hopeful patrons who were backing this experimentation.

Why did alchemy fall into disfavor? Not because the objectives weren't desirable, not because it didn't take elaborate training to become an alchemist, not because alchemists weren't sincere in their research efforts, not because they were't dealing with their "real" world; alchemy failed because it couldn't learn from the results of its experimentation that it was researching the wrong problem.

Those in procurement who take as their equest the transmutation of base procurements into golden ones are generally clustered around a point in time so late in the acquisition process that they enjoy the same degree of success as the alchemists.

What a tragedy if we are unable to learn from our past experimentations and merely recycle our "source selection, change order, cost overrun, performance shortfall, cost estimating" research efforts, unable to learn to ask better questions about what the substantive problems are toward which we should direct our research.

I leave it to you to test the validity of my remarks by answering these questions: "Do I know what I don't know about procurement management?" Can you say, "I have looked at the principal elements in the acquisition process and their interrelationships. I can deal with the generic source of procurement problems because I understand the context of procurement and the implication of individual elements in that context."? Unless we can answer these questions and deal with the implications of our answers on a comprehensive and timely basis, we may contribute little to the research which we need to help meet our management responsibilities.

ABSTRACT

CLOSING THE LOOP: RESEARCH NEEDS, PROJECT SELECTION AND EVALUATION

Paul F. Arvis

The necessity of evaluating research proposals and products is well documented; yet much evaluation takes place when agreed-upon criteria and methods are not available. There is a need to close the gap between this necessity and non-availability. The goal of research management is to make research more productive. But, in the absence of evaluation standards, it is difficult to assure effective project selection, control, and evaluation.

Governmental procurement research requirements currently exceed resources, accentuating the need for efficient selection and evaluation methods. The complementary relationship between selection and evaluation is manifested in the influence of research results on selection criteria as well as their potential influence on the efficiency of operations. Experiences of academia and industry provide some basis for the development of useful selection and evaluation procedures, but the nature of the Government's public as well as scientific and economic commitments creates unique problems. Neither theory-building nor return on investment, strictly speaking, are sufficient bases for the establishment of selection and evaluation criteria. The challenge is to extract that which is necessary to preserve

scientific authenticity and which is consistent with our needs <u>and</u> to build the rest on our own research experience -- as have other emerging disciplines.

The establishment of a procurement research project is not normally a discrete isolated decision based solely on the independent merits of the research topic or proposal itself; it involves balanced use of resources, external environmental pressures, and critical organizational needs, among other things. Traditional factors which must be considered in the research commitment phase include definability and significance of the problem, availability of a data base and appropriate resources, marginal relationships of estimated costs and benefits, and implementability of results. During the administration of a multi-project research program, there is a need to reevaluate factors as experience indicates the need for changing research priorities, being careful not to scrap projects just because a heavier environmental pressure is exerted. Milestone criteria need to be established at project outset for determining continued research in the light of anticipated discoveries or events.

Measures of research performance are more controversial and illusive than criteria for project selection. Quantitative models have been explored but generally abandoned. Yet the need for empirical measures remains -- to sustain the research investment as well as to guide research direction. Two general aspects of research evaluation are explored. Performance of the research itself can be examined from a number of bases: the degree to which "agreed upon" research objectives are met (not for exploratory research); efficient usage of research resources; maintenance of project schedules, etc. It is important to determine meaningful and reasonable project performance measures to maintain positive communications and cooperation between research and top management. Of greater importance, though more difficult to assess, is the potential value or worth of a research project. Determination of worth is normally hueristic and may transcend research objectives, but the relationship between worth measures and objectives requires continuing attention. Value or worth measures constitute the vital link between operational effectiveness and research effectiveness. In addition to research which results in measured increases in performance or cost effectiveness, we need to give attention to assessing research which results in opportunity identification -- alternative practices, process extension, pitfall avoidance. Field tests of research recommendations in actual acquisition operations are the most direct means of validating research results, though cause and effect relationships are difficult to establish. For, regardless of whether the scientific or academic integrity of a completed research project is established, if it works its right, at least for the time being. And, if it doesn't work, it is less than adequate, despite an "A" for the application of scientific method. The operational testing for a number of Army research project recommendations is examined, including procurement management methods, source selection techniques, and acquisition strategy approaches.

EVALUATING RESEARCH NEEDS AND VALIDATING RESEARCH RESULTS

Lt Col Daniel E. Strayer, USAF
Maj Lyle W. Lockwood, USAF

INTRODUCTION:

Much effort has been devoted over the years to managing research. Textbooks, formal courses, and extensive literature address management of research in the physical sciences. Still, much remains to be done if the full benefits of basic and applied research are to be realized. This is true despite the fact that the physical sciences have an entire profession, that of engineering, which is based on converting the theory and laws developed by researchers (operating at the frontiers of knowledge in their respective scientific specialties) into useful and used results.

The social sciences, of which management is a part, have no counterpart to the engineering profession; therefore, a dual challenge exists. Not only must researchers develop validated theory needed to meet managerial responsibilities, they must work with management to translate research results into useful knowledge capable of being used at the proper place, time, and intensity in the management of events. This challenge, which generally confronts management, is particularly significant for those who work in the procurement business (see Drucker's _Management: Tasks, Responsibilities, Practices_ for further discussion of this situation).

Lacking most of the advantages enjoyed by the physical sciences, e.g., laboratory conditions, measurability, replication, etc., the procurement community is charged with developing improved means for satisfying future requirements while discharging current responsibilities of immense complexity, futurity, and significance to the nation. High standards are expected and enforced. Demands are great and unrelenting. Therefore, the process of advancing knowledge, i.e., research as a facilitator of this advance, has particular importance to DOD procurement management.

The important procurement research management questions to facilitate this advance are: What research should be done? When are results needed versus when results will be available? How should research be performed and judged? Who should do the research, judge the products, and implement the recommendations? These questions demand answers if the challenges faced by procurement managers are to be met.

This paper will address three key questions which are particularly important to the understanding of the procurement research management challenge: What research should be done? When will research results be available? and How should research results be judged?

CONTEXT AND DEFINITIONS:

The subject of evaluating DOD procurement research candidate projects and validating research products must begin with a clear definition of important terms and concepts. In addition, both project evaluation and product validation should be based on appropriate and clearly stated premises.

Procurement is a broad term, but it has frequently been narrowly interpreted. For research management, however, the definition employed by the Commission on Government Procurement seems most suitable: "Techniques of requirements formulation, contract placement, production and contract management (including all functions involved in that process), and external factors which affect but also the external factors which affect the application of procurement techniques and the end result."

Having defined the arena in which research projects are to be conducted, it is helpful to establish what constitutes research and projects. Research is defined by Webster as, "Studious inquiry or examination; esp.: critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct interpretation or the practical application of such new or revised conclusions, theories, or laws." The same dictionary, defines projects as, "A planned undertaking." Combining these provides the following statement of purpose for DOD procurement research activity:

Planning and executing critical and exhaustive investigation to discover new facts and verify their interpretation or applicability to the processes of:

a. Establishing DOD requirements.

b. Deciding which requirements are to be procured from the civilian sector of the economy.

c. Placing contracts for the satisfaction of the requirements.

d. Assuring that the contracts are satisfactorily fulfilled.

e. Identifying and dealing with significant external factors which may influence the process.

All for the purpose of improving the efficiency and effectiveness of the DOD procurement/acquisition effort.

Two fundamental premises significantly impact research management.

a. Talent capable of performing useful research in the area(s) of concern is scarce and expensive. While it is sometimes alleged that the "publish or perish" requirements of academic existence today will bring us a never ending supply of experienced academic researchers, this is not supported by experience. True, there is considerable publish or perish pressure in universities. However, it is not true that academic researchers must welcome, or even willingly participate in, research involving an area as ill-defined, poorly measured, contentious, and misunderstood as the area of government acquisition or procurement.

b. Procurement research performance has an opportunity cost to operating Defense Department procurement/acquisition functions. Operating personnel are asked as either researchers or as data bases to expend resources supporting procurement research. With the responsibilities and workload pressures attendant upon procurement/acquisition managers, their time cannot be provided indiscriminately to support the procurement research process. However, management involvement is essential for improving our understanding of the operation of procurement processes, policies and organizations through research. Thus, the estimated opportunity costs and the benefits of proposed research must be clearly weighed by both operators and researchers.

The fact that research into the procurement/acquisition process is both costly to those concerned with the process, and demanding upon research performers, dictates stringent need elaboration and research project choice approaches. Frankly, only a few really good people are interested in performing research, and only a limited number of opportunities to perform meaningful research involving the fundamental actors and processes will be permitted. Thus, it is essential that the areas of concern be clearly defined.

THE PROJECT SELECTION PROBLEM:

The environment dictates that the selection of problems to be researched be approached with the utmost care. Yet, paradoxically, this is the area which is most frequently assumed rather than managed. There seems to be a general belief that operating management knows which problems need to and can be researched. Thus, all that is needed is some way of tapping that knowledge and linking it to various research sources. In fact, this session's title seems to presume a list of researchable projects simply waiting for willing researchers to provide "well-researched" answers to management.

This is not the case. Although numerous lists exist, only a few of the "problems" enumerated thereon can be researched as stated. They represent areas that are "current and choice." While the concerns are genuine and significant, usually they are not sufficiently defined to permit using research methodology to advantage. What symptoms, then, can policy makers and operators use to advantage to identify problems that can benefit from soundly-conceived and conducted research?

A noted management expert, Professor Leonard Sayles (1964), has offered a brief list of signals which frequently indicate the presence of fundamental organizational or policy problems.

a. Do the situations repeat in highly predictable fashion? In other words, are there recurring problems?

b. Do high amplitude problems arise frequently? These are major deviations from planned work flow patterns and organizational interactions.

c. Is the situation characterized by spiraling or long-chain problems: problems in one area which spread to other areas or groups.

These symptoms often indicate the presence of problems which require concerted study and managerial attention.

They do not, however, clearly identify the problem itself. Nor do they provide unfailing clues as to the sources of the problems they reflect. Sources are frequently found in the following areas:

a. Internal stresses and strains.

b. External forces, work groups, etc.

c. New factors, equipment, market forces, management controls, and management structures arising outside of a given organization.

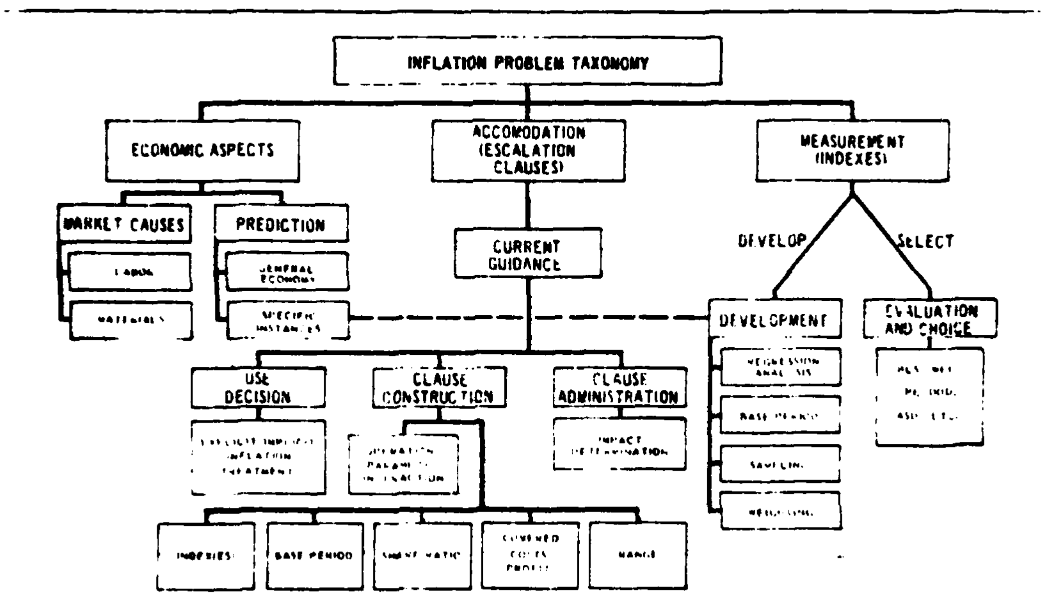
d. Unusually high pressure on elements of the organization.

Since many problems are not amenable for various reasons to research treatment procurement research management must adopt a rigorous method of identifying specific problems. Once identified, problems must be broken out of the overall situation precisely so that research methodology may be applied to their resolution. This means a more rigorous delimitation than is normally possible or perhaps even desirable for managerial action. In this difficult area, the Air Force Business Research Management Center is applying an approach based upon the tools of project management and social science/physical science research methodology.

PROBLEM DELIMITATION:

The first step in further delimitation of the problem area is to lay it into a decision tree type format. this is called a problem taxonomy. The term "taxonomy" was adopted because it most precisely describes our purpose: to depict the components of a process in their natural relationships and with as much precision as is possible. Consider, for example, the inflation problem taxonomy:

Figure 1
INFLATION PROBLEM TAXONOMY

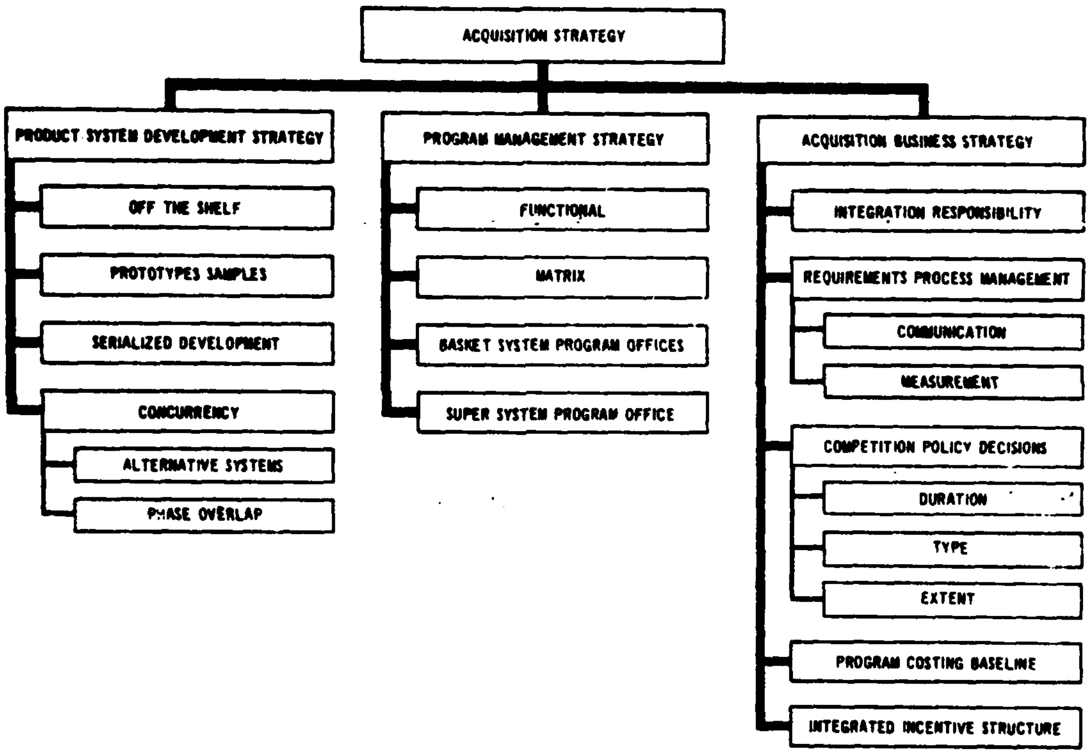


The inflation problem is viewed as consisting of three principal components: measurement, accommodation, and economic aspects. In other words inflation is, from the point of view of participants in a marketplace, largely a problem of measurement and accommodation. It helps to be aware of the economic aspects, but not much can be done with the knowledge at our level. It is necessary to be able to work effectively within the situation.

Accommodation has taken two basic forms. The use of estimated cost increases, certainly the most frequently employed, is not addressed although it has important ramifications. Here the concern is with escalation clauses. In evaluating current practice, three major considerations are faced: use of the clause, construction of the clause, and clause administration. At these decision points, accurate information is required, i.e., improved knowledge of the facts, to insure that decisions do not lead to unintended adverse consequences. Research can be directed, therefore, to each of the subheads noted. The inflation problem (to note the clause construction issues) has been brought down to specific dimensions of: indexes, base periods, share ratios, covered costs, and ranges. Research can be (and is being) sought and/or performed on various aspects of each of these specific topics. Each research effort becomes a project integrated into the whole and managed to insure orderly development of knowledge.

Consider another example: formulating an appropriate business strategy for acquiring major systems. The following taxonomy represents that problem.

Figure 2
ACQUISITION STRATEGY



The formulation of an appropriate business strategy requires placing that challenge in context within the total managerial challenge--formulating an appropriate acquisition strategy. Acquisition strategy can be viewed as consisting of a business strategy, a program management strategy, and a system or product development strategy.

Following the assertion that the need is valid and that acquisition is the process to satisfy that need, there is a search to select a system/product development strategy. The driver of this strategy selection might be technological state-of-the-art. The alternatives range from "off the shelf," i.e., no development effort, to a concurrency concept involving either the development of alternative technological systems or the overlap of traditional program phases.

As a function of information generated during the product development strategy selection process, market environment, and programming (i.e., cost and schedule) constraints, a business strategy is formulated. Recognizing that the selection of an internal business strategy is equally necessary, attention can be directed toward the key components of acquisition business strategy--assigning system integration responsibility; selecting a requirements communication and measurement process; deciding upon the duration, type, and extent of competition; defining a costing base; and developing an integrated incentive structure.

The selected system/product development strategy and the selected business acquisition strategy is then accomplished and tied together with a program management strategy selected from the basic alternatives indicated. This range of alternatives is primarily based upon the program manager's degree of resource self-sufficiency.

Although existing knowledge does not yet define a set of mutually exclusive acquisition business strategy alternatives, viewing the problem in this context provides both operators and researchers a framework to focus attention toward fundamental questions: What criteria should be used to make the selections within each primary strategy? Which combination of strategies yield the best results?

PROJECT SUPPORT AND RESULTS VALIDATION:

Having reached, at the bottom of the appropriate problem taxonomy, a more precise formulation of the problem involved, interface with someone (a sponsor) in the world of procurement operations must be established to assure meaningful results. This dialog confirms or denies the developed view of the world with that of experts with current perceptions of the day-to-day working situation. Problem articulation is checked to insure that the shred-out is meaningful. Research questions can then be developed to address the decisions to be made and their context.

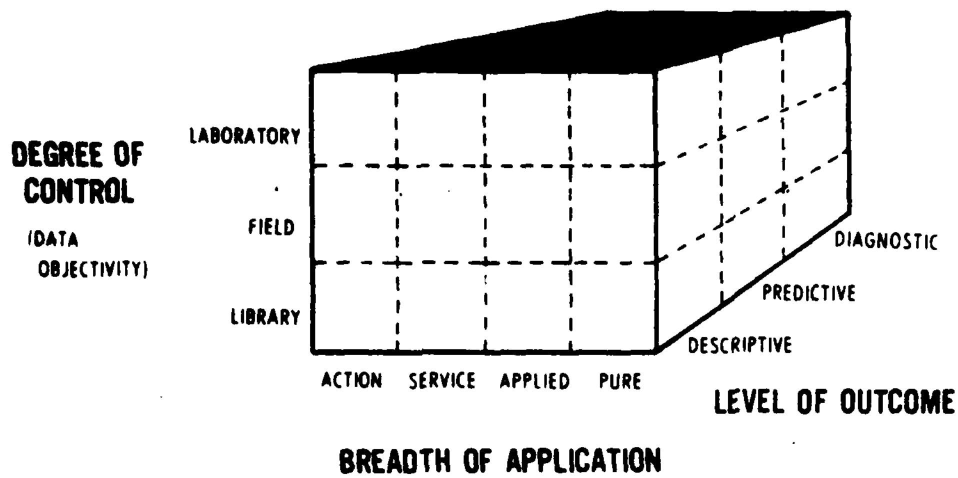
The appropriate problem statement is jointly developed by the sponsor and the researcher. Also, understanding is sought on any factors which become caveats or ground rules of the study. These caveats should be considered in the design of any research study to assure positive impact. Failure to have agreement on the problem and mutual understanding of the caveats from the start can severely impede the conduct of the research project and compromise the acceptability of research results.

Another critical aspect is data. If something is not repetitive and cannot be observed and measured, research will probably not materially advance understanding or develop solutions. On the other hand, if appropriate data are on hand (or can be accessed or created), research can penetrate the problem and seek solutions. Finally, at the outset, the sponsor's availability and willingness to support a research effort must be addressed. Whether it be in terms of the time of himself or of his organization, or in terms of the funds required to either contract or support a research effort, the sponsor's commitment is essential to success.

To further assist discussion of the problem with the sponsor, perceptions of the problem in terms of what can reasonably be done (given the time and other constraints of the problem situation) are evaluated. A particularly helpful framework for this evaluation is presented by C. G. Helmstadter.

Figure 3

RESEARCH STUDY TAXONOMY



This taxonomy describes the application question, which is the purpose of the research, against two important parameters--the degree of control over data or its objectivity, and the level of the expected outcome. Breadth of application refers to intended use of results. If the research is to serve as an immediate indication of concern, realizing that it is probably unlikely to produce much in the way of research results, it is designated as action research. At the other extreme, research designed to find the fundamental governing rules of behavior, is designated as pure research.

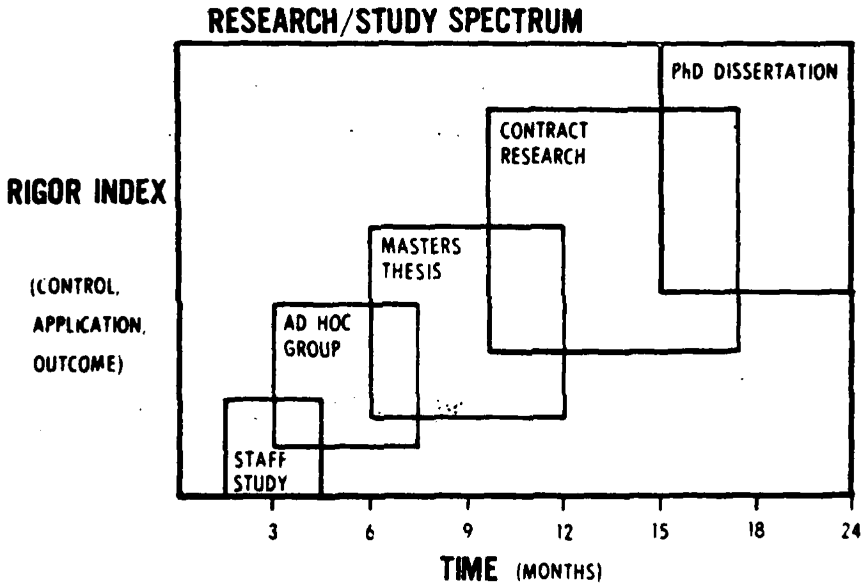
On the level of outcome dimension three basic possibilities are considered: descriptive, predictive, and diagnostic. As the name implies, descriptive research attempts to provide a rigorous and accurate description of the situation and the important variables. Predictive research aims at methods of predicting the behavior of these variables while diagnostic research adds the dimension of explaining <u>why</u> certain behavior patterns occur.

The degree of control over data ranges from library research, or reliance on past activity, through field research aimed at measuring present activity to laboratory research which aims at simulating under controlled conditions the important dimensions of activity.

Once the problem has been evaluated in these terms, one can assess the sponsor's expectations, aspirations, and desired results. The next question is, How much can be offered given the time constraints so frequently present?

Considering the rigor index to be a composite of the three points mentioned previously--application, objectivity, outcome--it can now be seen that rigor must be traded off in order to get responsiveness in approximately the framework shown in Figure 4. This is frequently a cause of considerable concern to people facing the pressure of deadlines and the uncertainty of decisions which must be made on less than complete information, but it is a realistic view.

Figure 4
SPONSOR INTERFACE



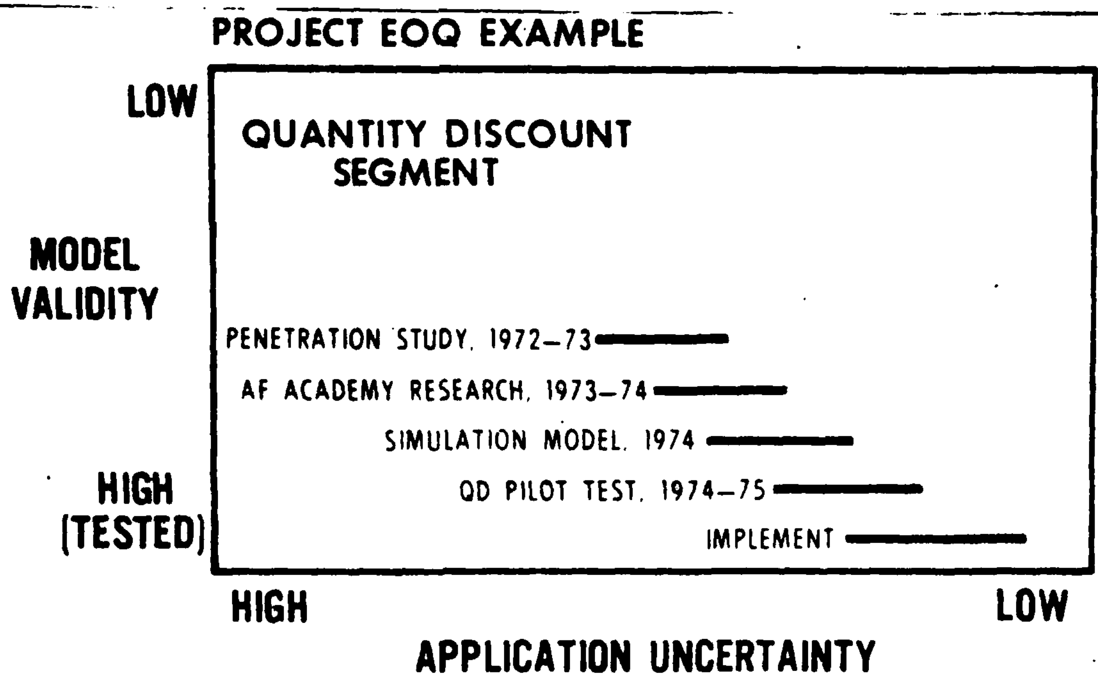
Once the problem has been delimited, the nature of the project has been defined (in terms of outcome level, breadth of application, and objectivity of source data), a need date established, and a support posture agreed upon, a research project emerges.

Research projects are handled in a project management approach. The assessment of quality consideration is now formally introduced although it is conceptually impossible to separate it from the problem of problem definition, research selection, and method planning. The quality assurance concept is one of planning for customer satisfaction. If the right question is asked, the right person asks it, and the proper research approach is employed, the resulting product will probably be helpful to the sponsor.

Quality assessment is a scientific problem involving questions of methodology. However, quality also involves translating the findings into meaningful management implications, and considering the possibilities of changing action patterns. Frequently, therefore, the problem is redefined and started through another research process to assure that the results will be useful to procurement and acquisition managers.

This requires a phase referred to as the orderly development of knowledge. It involves a rigorous, planned approach to "corporate memory." The important dimensions of this process are the degree of application uncertainty, which is operationally defined as confidence in the predicted outcome and the solution's validity. New methods, policies, processes, or models share a common problem. They are new. They are, to a greater or lesser extent, unknown. It is not certain that they can be properly employed by the system. Yet, if undesirable consequences are to be avoided, application predictability must be known before management commits itself to major organizational, policy, or process changes. Figure 5 presents the orderly knowledge development approach employed by the Air Force Business Research Management Center.

Figure 5
ORDERLY KNOWLEDGE DEVELOPMENT



Application uncertainty may partially explain "not invented here." "Not invented here" is frequently an essential reaction of an organization which does not have any way of assessing whether a proposed improvement would perform as advertised. This uncertainty is reflected along the bottom of the chart moving from left to right. If management is sure that results will be as advertised, new ideas can be implemented much more rapidly.

The validity of the model, the other major variable in the problem, is shown on the vertical axis. Models are essential to the management process and are used all the time. Regulations, or written models, or equations, which are mathematical representations of reality, are but two examples. The question here is the validity of the model in the context in which it is intended. In other words, do tests insure that the significant variables are in the model and that they behave as advertised?

This particular example shows the EOQ quantity discount model which was reported to two previous symposiums. At the time of last year's report, the project was in the final stages of pilot test. Since then the Air Force Logistics Command has implemented the approach command-wide. This demonstrates how the quantity discount model was adapted to the AFLC EOQ buying system, how it was tested, and how pilot tests were employed to insure both that the model worked as advertised and that it was usable by the requirements and procurement people involved.

THE LIMITS OF RESEARCH:

This paper has addressed three very significant research management problems: project selection, result availability, and results evaluation. It has described a rigorous approach to problem definition and research evaluation. It has demonstrated a sequential approach, based upon replication and pilot testing to the validation of results. However, many problems and solutions cannot be pilot tested. Policy development in these areas has yet to yield to pilot tests or, to the writer's knowledge, to simulation.

Some readers may have felt that the earlier listing of research management's big questions was incomplete; that a major question was left out. They are correct and the omission was intentional. The missing question can be asked now: What is to be done with promising results to real problems which cannot be pilot tested? And the corollary question follows: Who should make the decisions and take the actions?

At this point, it is necessary to return responsibility to management by completing the analogy with engineering that began this paper. In some ways the profession of management fills a position similar to the engineer. Responsible for combining resources so as to achieve the "best" solution to a given problem rests with the responsible manager.

Procurement research can work with management in facilitating improvement but cannot succeed on its own resources. With managerial support and access to significant areas of concern, research can in time provide the theory and laws needed to effect lasting improvements. But research cannot, and should not, control the implementation process.

The form and composition of the solution will be dictated by the situation and the evaluation criteria applied. Management's knowledge is required to develop the best solution. Management's leverage is essential to implementing the solution.

SELECTED REFERENCES

Drucker, Peter F. Management: Tasks, Responsibilities, Practices. New York: Harper and Row, 1974.

Helmstadter, C. G. Research Concepts in Human Behavior. New York: Meredith Corporation, 1970.

Report of the Commission on Government Procurement, Volume 1. Washington, D.C.: U.S. Government Printing Office, 1972.

Sayles, Leonard R. Managerial Behavior: Administration in Complex Organization. New York: McGraw-Hill, 1964.

United States Department of Defense. Proceedings of the Third Annual Procurement Research Symposium. September 1974.

United States Department of Defense. Proceedings of the Fourth Annual Procurement Research Symposium. October 1975.

SOME EXPERIMENTAL METHODS FOR CHOOSING RESEARCH CANDIDATES AND VALIDATING RESEARCH RESULTS

by

Wm. E. Souder, Ph.D.
Associate Professor of Industrial Engineering
and
Director of the Technology Management Studies Group
Department of Industrial Engineering
1048 Benedum Engineering Hall
Pittsburgh, PA 15261

Telephone No. (412) 624-5423

Presentation Time: Flexible (5-20 Minutes)

Visual Aid Needs: Overhead Projector for Transparencies

ABSTRACT

Research and development (R&D) project selection and evaluation decisions often take place at several levels of an organization, and are carried out by both individuals and groups. The selection and evaluation processes that are normally used appear to be highly diffuse, in that they involve many persons who have various essential pieces of information and sign-off powers. This information must be shared and the powers must be equalized if true organizational commitment is to be achieved. The process also appears to be very heuristic, in that goals, constraints, evaluation criteria and various viewpoints become more visible and better understood as the process unfolds. Thus, there is an apparent need for organized and methodical inquiry. A large number of operations research models have been proposed as aids to the project selection/evaluation process. These models have largely concentrated on the analytical problems of determining an 'optimum' portfolio of projects under conditions of limited resources. A number of other quantitative models have been proposed in which the worth or value index of a candidate project can be computed. Neither type of quantitative model appears to have been widely adopted or used for any significant lengths of time, although successful applications are known. It is interesting that these successful applications have not primarily involved using the models for their 'optimizing' or analytical properties per se, but rather for their contributions to organizational communication and decision-making. Other studies support the conclusion that the main contributions of project selection/evaluation models lie in their functions of bringing together information from diffuse portions of an organization and stimulating heuristic examinations of alternative portfolios, goals and constraints. This paper reviews the author's recent field experiments in the trial and use of organizational decision making models for R&D project selection and evaluation.

DISTINGUISHING GRANTS AND CONTRACTS

Susumu Uyeda
Assistant for Interagency Financial Management
Financial Management Branch, Budget Review Division
Office of Management and Budget

Prepared for presentation at the Fifth Annual Department of Defense Procurement Research Symposium; Naval Post Graduate School; Monterey, California; November 17-19, 1976.

A. General Background

During the last decade, there was a significant growth in Federal assistance and other support programs to State and local governments, universities, hospitals, and non-profit institutions and individuals. Assistance to State and local governments, for example, grew from $7 billion in 1960 to an estimated $56 billion in 1976. Frequently, new programs were established with program and administrative requirements which were inconsistent, overlapping or even contradictory from the perspective of recipients.

The executive branch undertook a massive effort to overcome these problems during 1969-1973 under the Federal Assistance Review (FAR) Program. Much was accomplished under the FAR including:

- establishment of ten common regional boundaries for Federal agencies;
- creation of Federal Regional Councils in the ten regions to coordinate Federal programs and to improve communication with State and local governments;

- reduction of red tape associated with grant programs;
- issuance of simplified and uniform administrative requirements for grants to State and local governments;
- reduction of grant application processing time; and
- implementation of the provisions of Intergovernmental Cooperation Act of 1968.

Despite these many improvements, there is general agreement at all levels of government that much more needs to be accomplished in streamlining and rationalizing the Federal assistance delivery system.

B. Commission on Government Procurement

During the late 1960's the Congress recognized the need for a comprehensive study of procurement practices throughout the executive branch. Public Law 91-129 was passed on November 26, 1969, and established the Commission on Government Procurement. The twelve-member Commission was charged with studying and recommending to the Congress methods of promoting "economy, efficiency, and effectiveness" in government procurement.

The Study report dated December 31, 1972, contained 149 recommendations to the Congress. Although the majority of these were concerned with strictly procurement transactions, two recommendations pertained to assistance programs:

Recommendation F-1: "Enact legislation to (a) distinguish assistance relationships as a class from procurement relationships as a class by restricting the term 'contract' to procurement relationships and the term 'grant,' 'grant-in-aid,' and 'cooperative agreement' to assistance relationships, and (b) authorize the general use of instruments reflecting the foregoing types of relationships."

Recommendation F-2: "Urge the Office of Federal Procurement to undertake or sponsor a study of the feasibility of developing a system of guidance for Federal assistance programs and periodically inform Congress of the progress of this study."

C. Congressional Actions

Pursuant to Recommendations F-1 and F-2, a bill (S. 3514) was introduced in the Senate on May 20, 1974. Related bills were also introduced in the House (H.R. 9059 and H.R. 9060). The proposed legislation distinguished procurement from assistance relationships, defined two basic types of "assistance" relationships (grant and cooperative agreement), and called for a feasibility study by the Office of Management and Budget (OMB) of developing a more comprehensive body of guidance for assistance programs. The Senate passed the proposed bill with slight modifications, on October 9, 1974, but the House failed to pass the bill or the related H.R. 9060 in the 93rd Congress. A similar bill (S. 1437) was introduced in the 94th Congress.

Generally, under these bills:

- a type of contract is to be used whenever the principal purpose of the transaction is the acquisition of property or services for the direct benefit or use of the Federal government;
- a type of grant is to be used whenever the principal purpose of the transaction is to accomplish a public purpose of support or stimulation and no substantial involvement is anticipated by the Federal agency; and
- a type of cooperative agreement is to be used whenever the principal prupose of the transaction is to accomplish a public purpose of support or stimulation and substantial involvement is anticipated by the Federal agency.

During the Senate hearings (June-July 1974) and House Hearing (November 1974), the Administration's witnesses testified that the definitions of "contract," "grant," and "cooperative agreement" were too general or too broad and may not be conducive to achieving the intent of the bill. It was, therefore, suggested that a feasibility study as provided in Section 8 of the bill be performed before the passage of the legislation. The initial phase of the proposed study would allow the Administration to consider a more distinct specification as to the meaning of "substantial involvement" and a clear specification to distinguish "contract" from other agreements. The OMB, with the assistance of Federal agencies, completed the study by December 31, 1975.

D. <u>Purpose and Methodology of Study</u>

The purposes of the initial phase of the study were to:

- determine what needs to be done to implement the definitions proposed in the bill for "contract," "grant," and "cooperative agreement" or to determine whether additional types of instruments are feasible;
- develop criteria for standard relationships and recommend specific definitions or methodology for classifying transactions into types of relationships.

The study was co-chaired by the Associate Director for Management and Operations of OMB and the Deputy Administrator of GSA. The study, being interagency in nature, was supported by an ad hoc policy level Steering Committee of senior level officials of major agencies including the Office of Federal Procurement Policy.

Two study Co-directors were assigned by OMB and GSA and were responsible for the conduct of the study under the general guidance of the Study Co-chairmen. In total, 16 full-time study team members were assigned by 13 agencies to participate in the study.

The study team first developed a 35 page questionnaire to gather data concerning actual Federal involvement in Federal programs. Approximately 50 programs from the major Federal agencies were selected for this purpose, and the study team members interviewed Federal agency officials to determine the nature and degree of Federal involvement in each program. The responses were tabulated to see if any discrete patterns of Federal involvement existed. Based on this analysis, several models of standard Federal involvement were developed and were subjected to discussion and refinement as the study progressed.

A separate questionnaire was developed to solicit information and opinion from Public Interest Groups, Industry Representative Groups, and other Associations. Comments concerning S. 1437 were solicited from twelve Public Interest Groups representing State and local governments, four university and hospital associations, and six other industry and professional organizations.

A questionnaire was also developed for recipients of Federal assistance and support. In addition to the Washington area, study team members visited Atlanta, Boston, Chicago, Madison, San Francisco, and Los Angeles and interviewed representatives of 7 States, 11 cities, 8 countries, 5 councils of governments, 4 special purpose governments, 2 community action agencies, 13 universities, 6 hospitals, 4 other non-profit organizations, and 4 profit making firms. Finally a separate questionnaire was used to interview Federal field officials.

E. General Conclusion of the Study

Except for the university community which generally opposed the bill, the study did not find overwhelmingly strong support for or overwhelmingly strong opposition to S. 1437. In general, those in favor of the bill supported it on the basis of the "standardization" that the bill would accomplish; whereas, those not in favor of the bill opposed it on the basis of how the bill might affect them adversely.

Most Federal agencies did not have strongly held views on the proposed definitions for and use of the three types of instruments, i.e., contracts, grants, and cooperative agreements. Their feeling was that the real problem would be in the degree of specifics to be included in implementing regulations, since otherwise they could readily implement the bill by merely changing "labels" of the instruments they now use. NASA, Air Force, and Army, however, opposed the bill, because the bill rescinds the Grants Act (Public Law No. 85-934) which currently authorizes them to make grants to support basic research at universities and other non-profit institutions.

The study report emphasized that the problems concerning Federal assistance programs most frequently affecting the recipients would not be solved solely by standardizing types of transactions, legal instruments, or Federal involvement. The problems foremost in the minds of the recipients were things like:

- inconsistent implementation of standard administrative requirements contained in Federal Management Circulars (FMC 74-7 and FMC 74-4);
- lack of uniform treatment of indirect costs;
- different audit requirements or different interpretations of the same rules and regulations by Federal, State and local auditors;
- problems associated with cost sharing and matching;
- excessive reporting requirements on program matters;
- Federal requirements involving further standardization;
- lack of opportunity to compete for awards (profit-making organizations);
- lack of information on availability of grants (small local governments).

In general, recipients would like the Federal Government to focus on these problems rather than on standard relationships or legal instruments.

Some recipients felt that they knew in advance the degree of Federal involvement, either through past experience or from rules and regulations issued for the programs. Most, however, stated that it would be helpful to have advance descriptions of Federal involvement, including involvement which precedes awards. Their emphasis was on "advance information" rather than "standard relationships." They would like to avoid unanticipated changes in Federal policies, procedures, personnel, or organizations which at times cause abrupt changes in Federal involvement.

From the vantage point of most recipients, contracts, grants, and other agreements are treated virtually alike except for specific clauses and conditions. Most of the recipients interviewed could not identify the "labels" nor did they feel that they needed to. If Federal roles and involvement were more consistent, they would, in general, prefer minimum control on the part of the Federal agencies.

F. Study Conclusion on the Definitions

In spite of varying viewpoints on the bill, the study fully supported the concept, philosophy, objectives, and goals of the bill. The study concluded that, with some modifications as proposed in the report, the bill would go a long way towards establishing an overall framework to standardize, simplify, improve, and clarify the relationships between the Federal agencies and the recipients of Federal awards. Such a framework would provide the opportunity for more orderly administration of Federal programs and would be useful: (1) to Federal agencies in evaluating the type, extent, and propriety of their involvement, (2) to the recipients in understanding the nature and degree of Federal involvement in advance or at the time of the awards, and (3) to the Congress in formulating program policy and exercising its oversight responsibilities.

1. Contracts There were no strong opposition to the definition of contracts in the bill. It was indicated that it would be useful if the legislative history included additional examples to clarify the use of procurement contracts when goods and services are purchased for beneficiaries of assistance programs.

Moreover, most research programs contain elements of assistance and procurement. Even with the definitions of procurement and assistance contained in the bill, there are still other factors which improperly influence the selection of instruments by Federal agencies. These factors include the dissimilarities between the selection process used for grants versus contracts, announcement or solicitation procedures, matching and cost sharing requirements, payment procedures, and differences in the grant and contract instruments. If the bill is to achieve one of its primary objectives of eliminating unnecessary requirements in Federal awards, the total processes of procurement and grant systems must be looked at together to determine which changes should be made. This should be accomplished as a part of the study proposed in the bill.

When this work is completed, the Federal agencies will be in a better position to sort transactions into procurement of assistance categories without being influenced by the aforementioned factors. The results of this work may be also beneficial to non-research programs where similar problems may exist but to a lesser degree.

2. <u>Cooperative Agreements and Grants</u> In the assistance support area, the bill proposes two basic relationships--a cooperative agreement with substantial Federal involvement and a grant with no substantial involvement. First, the study proposed that the term "cooperative agreement" not be used for Federal assistance or support. The term "cooperative agreement" should be reserved for transactions in which Federal agencies enter into partner or joint venture type relationships with State and local governments and other organizations on work which is part of or directly related to a Federal agency's operating mission and which is mutually beneficial. These agreements should include relationships in which the participants agree to coordinate and cooperate with each other in performing their respective but related missions or to share the results of each others' work.

Secondly, the study concluded it would be most difficlut to categorize the Federal assistance transactions based on the degree of Federal involvement. The first problem was defining the term "involvement" and then the term "substantial."

For "involvement," it was necessary to identify the types of grantee activities in which the Federal agencies could become involved. The following activities were determined to be most significant in identifying the degree of Federal involvement:

- Participation in program planning during operations,
- Frequency and use of performance reports,
- Frequency and purpose of site visits,
- Frequency and use of financial reports,
- Control over selection of key personnel and approving staffing pattern,
- Control over subgranting process, and review or approval of awards, and
- Control over the contract and subcontracting process, and review or approval of awards.

For each one of the activities, it was found that there could be three levels of involvement:

- Federal direction and control over grantee's operation,
- Technical direction or assistance provided by Federal agencies voluntarily or at the request of grantees with little or no strings attached, and
- Little or no involvement on the part of Federal agencies.

The study concluded that a systematic method would be needed to inform the grantees the extent of Federal involvement for a given award and to generally categorize Federal involvement based upon the levels of involvement in the various grantee activities.

3. Federal Involvement in Pass-Through Grants The study also concluded that the definitions in the bill per se would not particularly be effective or helpful to local governments which receive Federal aid as a pass-through from the States or other local governments. The bill attempts to standardize the Federal involvement and instruments, but only the primary recipient would be affected. The State governments passing Federal aid on to local governments would be free to use their own instruments and establish their own policies concerning involvement in the programs. This is because the Federal Government traditionally has avoided interfering with the internal affairs of State and local governments.

Therefore, in order to fully realize the intent of the bill, Federal agencies should urge State governments to achieve more consistent patterns of State involvement. Also, Federal agencies should require the States to communicate specifically the intended Federal involvement in subgrantees' and subcontractors' activities. In this manner, subgrantees and subcontractors will have knowledge of the intended Federal role in advance.

G. Executive Branch Position

Although the Administration indicated its reservation subsequently, the Congress passed the bill and submitted it to the President for his approval. In withholding his approval from S. 1437, the President stated that:

> The Office of Management and Budget completed a study, almost a year ago, of the definitions of "grant," "contract" and "cooperative agreement." That study, which has been reviewed by other Federal agencies, public interest groups, and other interested associations and groups, confirmed support for the objectives of this legislation but lead to serious questions as to whether at this point legislation is necessary or desirable.
>
> No matter how careful the drafting, a bill which requires thousands of transactions to be placed into one of three categories will probably result, in many cases, in limiting the programmatic flexibility of Federal agencies and creating a large number of technical difficulties for them. Federally supported basic research programs would be particularly difficult to classify in terms of the definitions in this bill.
>
> The Office of Management and Budget is continuing to work in this area with the cooperation of other Federal agencies. It plans to issue policy guidance to Federal agencies that would more clearly distinguish between procurement and assistance transactions and establish better defined patterns of assistance relationships between Federal agencies and funding recipients.
>
> In addition, OMB has been developing more comprehensive guidance for assistance programs, as indicated by the recent circulars issued by the agency establishing uniform administrative requirements for hospitals, universities, and non-profit grantees. I am directing OMB to continue to emphasize such activities.

Subsequent modifications and refinements can be made in these directives when further operating experience and evaluation suggest they are needed. This kind of evolving set of activities in the Executive Branch, a step-by-step process which learns from experience, is preferable to another lengthy study as required by this bill.

In view of the extremely complex and changing nature of Federal assistance programs, I believe that Congress should not legislate categories of Federal assistance relationships, but leave the number and nature of such classifications to the Executive branch to determine and implement. If experience from the kind of studies and evaluations now underway demonstrates that legislation is required, that experience would also provide a far better foundation for formulating legislation than we have now.

H. Concluding Comment

As the President has indicated, OMB is working to administratively implement the objectives of the bill. OMB has drafted a circular which would promulgate government-wide criteria for distinguishing procurement, assistance, and cooperative agreement transactions. This circular is now undergoing an OMB, in-house review and has been informally discussed with some of the Federal agencies.

The next step would obviously be formally to solicit comments from the Federal agencies and other interested parties. As we have found in the last two years, the feeling among agencies concerning definitions and their implementation varies widely. There may be some strong disagreements in these matters. We hope that this process will be constructive and productive in finalizing the definitions and implementing the objectives of the Congress and the Procurement Commission. We also hope that the resultant system be one that would be useful and beneficial to the Congress in exercising its oversight responsibilities, to the Federal agencies in managing their programs, and to the recipients in understanding the Federal roles and involvement ahead of time.

Also, OMB will continue to develop more comprehensive guidance for assistance programs as directed by the President. This is truly consistent with the bill and the recommendations of the Procurement Commission.

AN ANALYSIS OF FEDERAL GRANT PROCESS

I understand that most of you are familiar with the report of the Commission on Government Procurement and are aware that it dealt, to a limited extent, with grants. Why there are grants at all, who gets them (and who doesn't), under what procedures they are awarded, and from what statutory base they are derived is often a mystery to the uninitiated. During the course of this talk, I hope to deal with some of these questions and perhaps, clarify for you some common misconceptions.

First, however, a one minute exposition on a phase of American history with which you may be unfamiliar. As far as I can determine, the first grant of money by the Federal government was made in 1836. At that time the debts of the individual states amounted in total to about $170 million while, at the same time, the Federal government was enjoying a surplus of revenues over expenditures. Under those circumstances, Congress passed the Surplus Distribution Act of 1836 providing for a distribution of most of the Federal government's surplus to be apportioned among the states in four quarterly installments based on each state's representation in the Congress. Three of the four installments were paid in 1837

Prepared for presentation at the Fifth Annual Department of Defense Procurement Research Symposium; Naval Post Graduate School; Monterey, California; November 17-19, 1976

Matthias Lasker
Director, Division of Grants Policy and Regulations Development, HEW

amounting to approximately $28 million. The fourth installment was never paid as a result of a sharp economic recession that occurred later in the year. Although the distribution of this Federal "largesse" was ostensibly to be a series of loans to the states, there appears to have been no intention that the distribution be anything but a gift, and no repayment was ever called for or made.

Let's relate this brief historical treatise to today's situation. The magnitude of Federal financial assistance and support through grants has increased astronomically since 1836. In fiscal year 1976, for example the Federal Government awarded in excess of $64 billion in grants to state and local governments, colleges, universities, hospitals, community action agencies, research foundations, and the like. Although the 1836 grants were to assist the states out of their financial distress, most present day grants are awarded either to assist the grantees carry out responsibilities that are basically theirs but that cannot be fulfilled without some Federal contribution, or to stimulate them to undertake activities thought to be in the interest of the citizenry. So, for example, there are grants for public assistance, the delivery of health care, the operation of child day care centers, the building of public roads, the construction of hospitals, and other service oriented facilities, and the performance of research in the physical, biological and social sciences.

But what is a grant? Lawyers argue about the definition. Many make the case that grants are contracts, enforceable as such, because grants include those essential characteristics of contracts such as, offer and acceptance, competent parties, and mutuality of agreement. Others make the case that grants more nearly approximate trust agreements, while still others characterize grants as conditional gifts. With your permission, I'd like to avoid the pitfalls of attempting a legal definition because it seems to me that the important issue is not so much the definition as it is the purpose of grants. Why do they exist at all and what are their essential purposes?

You'll recall that the Surplus Distribution Act of 1836 provided funds to the states in order to assist them out of a financial "bind." The Congress did not intend for the states to perform any particular service for the Federal Government with the funds, or to provide any product either to the Federal Government or any third party. In effect, the funds were provided as an unconditional gift for the states to use as they saw fit. Times have changed. Most current Federal grants no longer are gifts or unconditional redistributions of tax revenues, with the major exception of the recently reenacted $25 billion general revenue sharing program. Instead most current grants almost invariably provide funds with a great many conditions and restrictions, several of which are established by statute, while others derive from published regulations. These conditions and restrictions deal with such issues as using the funds for certain defined purposes only, requiring financial accountability, assuring community involvement in how the funds will be expended, abiding by certain restrictive costing principles, assuring compatibility with civil rights provisions, and many others. At present the purposes of Federal grants run the gamut from support of exotic biomedical research to the construction of the interstate highway system; from strengthening state and local law enforcement and criminal justice systems to supporting American scholars abroad; and from controlling rats in urban areas to financing archeological studies in areas affected by Federal water resource development projects. There are, in fact, about 1000 separate Federal assistance programs, over half of which use grants as the mechanism for providing funds to the performers. Whatever their individual purposes, however, grant programs are almost invariably established by the Congress in order to improve the quality of life for all Americans and not to result in the provision of services or products for the Federal government.

I think it would be beneficial for you to have an awareness of two major categories of grants and some of the similarities and differences between them so that you can relate these similarities and differences to traditional procurement practices.

If we consider a major Federal granting agency like HEW, we find that grant awards last fiscal year approximated $30 billion in appropriated funds. (Those $30 billion, incidentally, do not include the social security and medicare programs which, between them, amounted to almost $85 billion). The preponderance of the $30 billion, about $24 billion in actuality, was awarded as non-discretionary, or formula grants while the $6 billion balance was in discretionary or project grants, a large number of which were for research.

There are several significant differences between discretionary or project grants, and non-discretionary or formula grants. First, in non-discretionary grants, the amount of a grant is almost always a function of the sum appropriated by Congress for the program and the workings of the formula that is included in the program legislation by the Congress. Usually, in the types of human resources programs administered by HEW, the formula incorporates certain demographic or population characteristics of the nation as a whole and then allots to each state, based on its peculiar population or demographic characteristics, a proportional share of the total appropriation. The result of all this is that HEW has no discretion in the amount of a formula grant. Contrast that with the normal procurement process. A second major characteristic of non-discretionary grants relates to the issue of whether a grant will be awarded at all. Here also, HEW has no choice since, in most instances the award of these grants involves no negotiations whatsoever; if the eligible state agency submits an acceptable plan certifying that it will abide by the appropriate statutory and regulatory requirements, a grant is awarded. Here too, note the difference with federal procurement practice.

A third feature of non-discretionary grants revolves around the issue of competition. Purely and simply, none is intended and none takes place. This is merely a corrolary of the two features that I just mentioned and stems from the fact that the eligible recipients have an enforceable legal right to receive their grants if they comply with the applicable laws and regulations.

A fourth characteristic of most HEW non-discretionary grants is that the only eligible recipient is usually an agency of State government, such as the State Health Department, or the State Welfare Department.

Let's turn now to the so called discretionary or project grant, one purpose of which may be the performance of research. Here we find a much closer analogy to the Federal contract in that a substantial degree of discretion is allowed the Federal agency. For example, on discretionary project grants there is no formula included in the legislation. As a result the amount of a discretionary grant is not predetermined but instead is subject to negotiation by the granting agency. Discretion also lies in the granting agency as to whether a grant will be awarded at all and, operating within the constraints of the legislation establishing the program, a variety of applicants may be eligible, allowing the concept of competition to enter very strongly into the award of most project grants. In other words, as far as discretionary grants are concerned, there are several distinct similarities with the process involved in Federal procurement.

There are also, however, a great many dissimilarities that should be mentioned. First, for example, is the basic concept and purpose of the grant as differentiated from that of the contract. I'll remind you again of the general concept of support, assistance, and stimulation that is characteristic of most grants and how that differs from the general concept of procurement wherein a service or product is generally to be provided to the Federal Government for its use.

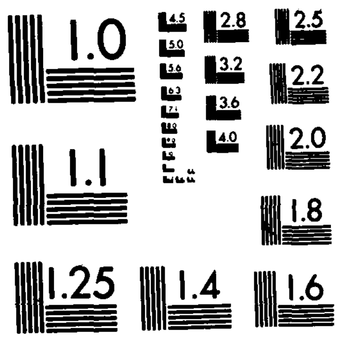
Second, is the fact that grant programs grew more or less like Topsy with the result that there is no single statute, such as the Property and Administrative Services Act to establish the rules by which the programs operate. There is no equivalent to the Federal Procurement Regulations or ASPR in grants. Instead most grant programs are subject to statutory and administrative provisions peculiar to themselves, affecting eligibility for grants, the review processes to be followed in award, and the terms and conditions or provisions of the grants themselves. This doesn't mean that there aren't areas of consistency among Federal granting agencies in the processes and terms and conditions used in grants. More about that from Mr. Uyeda. Since you are familiar with Federal procurement practices, let me identify some of the statutory and administrative requirements of most project grants that would be unusual, to say the least, in the Federal procurement process.

- Many grant applications (or proposals if that term is more comfortable) are subject to review and comment by State and regional clearinghouses before they are submitted to the Federal agency. The purpose of this review and comment is to encourage the establishment and operation of this network of State and areawide planning and development clearinghouses to help in coordinating Federally assisted projects with State, areawide and local planning for orderly growth and development and to assure that there is an expeditious process of intergovernmental coordination and review [illegible] proposed projects.
- Most grants are subject to a "maintenance of effort" or "no supplant" provision which requires the grantee to expend from sources other than the grant itself amounts equal to that spent in a particular base period before payments can be made under the grant. Research grants are not, however, generally subject to this provision.

- Payments on most grants are made prior to incurrence of costs by the grantee, either by letter of credit or Treasury check.
- On many grants there is potential for the grantee to receive considerable grant related income from third parties. The Federal government has accountability requirements to assure appropriate disposition of that income.
- Most grants are not subject to many of the traditional "public policy" provisions that are included in the boilerplate of Federal contracts unless the legislation establishing the grant program specifically incorporates these "public policy" provisions. I'm referring, for example, to such provisions as Use of Convict Labor, Buy American, Davis-Bacon, Walsh-Healy and the like.
- Most grants are not subject to "affirmative action" requirements and, in the event of noncompliance, most grants are not withheld pending resolution of compliance issues.
- Most grants are subject to "matching" or "cost sharing" requirements that prohibit the Federal Government from paying for the full cost of a project

AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76 4/7

UNCLASSIFIED F/G 15/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

but, instead, require the grantee to have a financial interest, in some cases relatively small and in other cases, relatively large.

- o Most grants require accountability to the Federal Government in that they do not have fixed price or lump sum characteristics but are almost always cost type. Grants do not have a factor for profit either.

I could go on at some length describing more of the features of grants that would be peculiar to the usual Federal procurement practices, but that shouldn't be necessary. Instead, let's deal more specifically with research grants.

-- First, research grants are almost always awarded to non-profit organizations and institutions, with universities the recipients of the largest portion of research grant dollars. The majority of research supported by Federal grants to universities is, as one might expect, for basic research and the principal fields supported are research in the bio-medical and physical sciences. The greatest portion of that grant support is provided by the National Institutes of Health, a part of HEW, and the National Science Foundation. After I've finished my remarks, I'll give you a copy of some materials that you may find of further interest in this area.

-- Second, it is generally standard practice for research grants not to pay the full cost of any research project.

In other words, the grantee shares a portion of the cost. In the case of HEW and the National Science Foundation, their appropriation statutes prohibit them from awarding research grants paying for the full cost of projects. In the case of most other Federal agencies, the practice is administratively imposed.

-- Third, most Federal research grants are awarded only after a competitive process of evaluation that is normally carried out by peer review groups. Very few research grants are awarded on, what would be characterized in procurement language, a sole source basis. Under the traditional peer review procedure used by NIH, panels of reviewers meet together to evaluate the scientific merit of several hundred applications. Each application is assigned a numerical score by each panel member. The arithmetic means of these scores are computed, and then normalized to a specified mean and standard deviation common to all the review panels.

The review panels invariably include a majority of scientists who are not employees of the Federal Government but are, instead experts in the particular bio-medical discipline or field of research pertinent to the applications being reviewed, usually from medical and graduate schools.

-- Fourth, once an award has been made, the investigator on a typical research grant has considerable discretion in carrying out the project. He may, for example, change the methods and procedures employed without the need to seek prior HEW approval. Significant changes in methodology are normally reported to HEW in periodic or final progress reports. In the event, however, that the methodology or experiment is stated as a specific objective of the research project, then the prior approval of HEW would have to be obtained. Of course, the investigation may not change the phenomenon under study without seeking the prior approval of the agency.

As mentioned earlier, I have some handouts for you. Perhaps we can look at those materials now.

OBLIGATIONS OF SELECTED FEDERAL AGENCIES FOR RESEARCH & DEVELOPMENT TO UNIVERSITIES AND COLLEGES, RANKED IN DESCENDING ORDER TO AMOUNT RECEIVED, BY AGENCY, FY 1975

(DOLLARS IN THOUSANDS)

RANK	INSTITUTION	TOTAL	USDA	COM	DOD	ERDA	EPA	HEW	INT	NASA	NSF	DOT	OTHER
	UNITED STATES TOTAL	2,222,559	110,534	22,173	190,462	110,101	33,809	1,189,431	27,162	100,216	397,296	17,804	14,571
1	MASS INST OF TECH	68,655	18	908	11,457	10,906	290	15,386	550	7,529	18,799	2,281	535
2	UNIV OF WASHINGTON	59,805	422	2,065	5,268	2,932	568	35,036	625	767	12,110	10	0
3	STANFORD UNIV	58,293	0	135	6,685	1,338	163	31,414	228	4,308	13,474	92	456
4	UNIV OF CAL-LOS ANGELES	53,749	0	0	3,811	6,053	116	34,186	74	1,917	7,307	190	95
5	HARVARD UNIV	48,532	0	15	1,887	1,609	287	32,953	0	3,344	8,374	0	63
6	UNIV OF CAL-SAN DIEGO	48,523	0	15	8,007	1,856	31	18,018	103	3,924	16,569	0	0
7	COLUMBIA UNIV	48,235	0	25	4,549	2,801	219	25,897	87	1,637	12,591	0	429
8	UNIV OF WIS-MADISON	46,331	2,418	850	751	4,436	1,027	27,667	167	1,794	7,057	91	73
9	UNIV OF PENNSYLVANIA	43,390	42	7	2,211	1,761	0	30,502	64	243	8,179	172	209
10	JOHNS HOPKINS UNIV	40,909	0	258	853	1,189	80	34,158	0	604	3,460	277	30
TOTAL 1ST 10 INSTITUTIONS		516,420	2,900	4,278	45,479	34,881	2,781	285,217	1,898	26,063	107,920	3,113	1,890
11	UNIV OF CAL-BERKELEY	40,357	890	1,321	4,499	839	177	14,047	347	5,080	12,613	419	119
12	UNIV OF MINNESOTA	39,895	2,501	18	696	2,224	915	27,554	401	1,784	3,547	48	9
13	CORNELL UNIV	39,476	2,800	36	2,106	1,568	178	16,375	443	1,494	13,908	62	506
14	UNIV OF MICHIGAN	38,203	172	184	2,567	2,305	862	21,172	0	1,876	7,269	1,485	311
15	UNIV OF CHICAGO	38,082	0	75	640	3,862	5	23,132	0	2,990	7,378	0	0
16	YALE UNIV	36,514	28	15	1,535	8,10	0	27,383	0	156	4,238	0	57
17	UNIV OF ILLINOIS-URBANA	33,841	2,503	50	6,229	3,703	341	6,196	309	1,108	12,131	636	635
18	UNIV OF CAL-SAN FRANCISCO	33,462	0	0	709	1,143	0	31,109	0	25	476	0	0
19	WASHINGTON UNIV (MO)	30,679	0	0	277	259	522	25,535	0	1,098	2,839	149	0
20	UNIV OF SOUTHERN CAL	28,174	0	674	5,524	213	32	16,881	96	643	2,914	1,197	0
TOTAL 1ST 20 INSTITUTIONS		874,903	11,800	6,649	70,261	54,099	5,813	494,601	3,494	42,317	175,233	7,109	3,527

(DOLLARS IN THOUSANDS)

RANK	INSTITUTION	TOTAL	USDA	COM	DOD	ERDA	EPA	HEW	INT	NASA	NSF	DOT	OTHER
	UNITED STATES TOTAL	2,222,559	110,534	22,173	190,462	110,101	33,809	1,189,431	27,162	100,216	397,296	17,804	14,571
21	NEW YORK UNIV	27,609	0	55	1,195	2,488	46	20,206	76	699	2,639	0	205
22	UNIV OF ROCHESTER	25,222	0	0	798	4,401	35	16,208	0	116	3,585	0	79
23	YESHIVA UNIV	24,782	0	0	437	50	0	23,664	0	11	620	0	0
24	DUKE UNIV	24,180	10	0	826	964	351	19,746	161	133	1,989	0	0
25	UNIV OF TEXAS AT AUSTIN	23,307	0	16	9,466	3,121	343	4,924	10	1,216	3,556	361	294
26	UNIV OF MIAMI	22,578	18	597	2,343	297	470	13,349	35	409	4,637	423	0
27	UNIV OF COLORADO	22,150	24	634	713	1,114	148	12,919	434	2,185	3,988	0	0
28	PURDUE UNIV	21,236	2,439	120	2,736	1,070	297	5,257	289	2,167	6,214	51	596
29	CAL INST OF TECH	20,995	0	163	1,775	2,294	291	5,890	252	3,332	6,998	0	0
30	OHIO STATE UNIV	20,711	2,798	83	2,460	618	637	9,536	313	344	2,360	690	872
TOTAL 1ST 30 INSTITUTIONS		1,107,682	17,089	8,317	93,010	70,516	8,431	626,300	5,064	52,929	211,819	8,634	5,573

GRANTS PROCESS IN THE AIR FORCE

Mr. John V. Walsh

1. The Department of Defense is responsible for assuring that the scientific research necessary to accomplish its mission is given adequate support. During the period up to the year 1958 the Department of Defense was limited to the use of contracts exclusively in obtaining research from the scientific community. Just prior to 1958 Congress had recognized the need for a simple economical and effective instrument, unencumbered by many of the contract provisions, to allow certain freedom and creativity to the scientific community in pursuit of research. To this end legislation was enacted which resulted in the Grant Authority P.L. 85-934.

2. Section 1 of the Grant Act states:

"That the head of each agency of the Federal Government, authorized to enter into contracts for basic scientific research at nonprofit institutions of higher education, or at nonprofit organizations whose primary purpose is the conduct of scientific research, is hereby authorized, where it is deemed to be in furtherance of the objectives of the agency, to make grants to such institutions or organizations for the support of such basic scientific research."

3. Section 2 provides discretionary authority, where it is deemed to be in furtherance of agency objectives, to vest in such institutions or organizations, title to equipment purchased with such grant or contract funds. Section 3 provides for an annual report to Congress of the number and dollar value of grants made pursuant to the Act and of the institutions in which title to equipment was vested. This part has since been deleted.

4. While the authority provided by P.L. 85-934 is quite broad and general, a series of implementing directives have been issued by the Department of Defense imposing certain limitations and restrictions on the use of grants by the military departments. Of these, DOD Directive 3210.2 remains in force. This DOD directive establishes policy on research grants and title to equipment purchased under grants. This directive provides for in part:

a. Use of Grants - A grant will be limited to the support of those research (authorized by P.L. 85-934) projects which meet relevant research requirements of the Department of Defense.

b. Awarding a Grant - Prior to award, Grantee must have complied with the Civil Rights Act of 1964, through Letters of Assurance, and certain environmental factors.

c. Qualification of Grantee - Grantee must be a qualified educational institution or nonprofit organization whose primary purpose is the conduct of research.

d. Title to Equipment - Title to equipment purchased with research funds shall be vested in the grantee organization as follows:

(This is essentially the same procedure as for contracts under ASPR)

(1) For each item of equipment having an acquisition cost of less than $1,000 title shall be vested automatically in the grantee organization upon acquisition.

(2) For items of equipment having an acquisition cost of $1,000 or more title shall be vested in the following manner:

"Title to Government property furnished for performance of work under the grant and purchased with research funds will normally vest in the grantee upon acquisition. If there is a genuine basis for expecting that a Government need will exist at the end of the research period, title will vest in the grantee upon acquisition subject to a right of the Government to direct transfer of the title to the Government or to a third party authorized to receive it within 12 months after completion of the grant. If the contracting officer determines that vesting of title in the grantee would not be in furtherance of the DOD's research programs, title will vest in the Government."

e. Contents of Grant - Grant agreements shall be brief and contain only those provisions which are required by statute or are necessary for the protection of the fundamental interests of the DOD. Provision shall be made for:

(1) Maintenance of adequate records to document the actual amount of any participation and to determine whether grant funds are properly expended.

(2) Appropriate patent and data rights

(3) Revocation of the grant.

(4) The grantee organization to:

(a) Obtain approval from the grantor agency before changing the principal investigator.

(b) Keep the grantor agency informed of any desired major deviation from the planned work and progress under the grant.

(c) Furnish results of all research to the grantor agency.

f. Cost sharing - Cost sharing (participation) in the support of research shall be encouraged, except when the organization has little or no non-Federal sources of funds from which to make a cost contribution.

GRANT CONTROLS

g. While many of the checks and balances inherent in cost reimbursement contracts either do not appear, or appear in a more relaxed form, in our grants, adequate controls are provided to insure that our grants properly protect the Government's interests, and neither the quality or quantity of research results obtained have been adversely effected by their use. To insure that available funds are employed in such a manner as will be most likely to provide the Government with the maximum return for its investment, the need for certain safeguards and controls is obvious. Some of the areas in which such need has been recognized, and the extent to which our grant procedures satisfy this need, are as follows:

(1) Basic research proposals are selected for support without regard to the type of instrument which will be used. A small percent of the proposals received are ultimately selected. This selection is based largely on the relative scientific merit of the technical proposal and the standing of the prospective investigator, and the institution with which he is affiliated, in the scientific community. Only after a proposal has been found to merit support, based purely on scientific and technical considerations in competition with all others, is consideration given to the amount of funds requested and the form of research agreement to be employed. In such a highly competitive climate, we are reasonably assured of high-quality research results regardless of the method by which support is provided.

(2) The same criteria are used in determining whether proposed costs are fair and reasonable, costs are subjected to the same degree of

analysis, negotiations are conducted in the same manner, and determinations as to reasonableness are equally substantiated, regardless of the type of research agreement to be used.

(3) A number of essential controls are provided by the grant document, itself. Among these are the following:

(a) The grantee's research proposal is incorporated by reference. The grantee agrees to adhere thereto in the conduct of the research. While the nature of basic research is such that the widest practicable lattitude for its conduct should be provided so long as there is not a departure from the objectives forming the basis for its selection for support. We make no attempt to direct the manner in which the research is conducted, but do provide safeguards against undesirable departures through a system of technical monitorship and retention of a unilateral right to revoke the grant at any time.

(b) Grant Brochures for basic research are incorporated by reference. They generally establish the framework within which the research project will be conducted and the grant will be administered. It makes appropriate disposition of such matters as relate to patent rights, rights in technical data, revocation, security, unexpended funds and earned interest, title to equipment, equal employment opportunity, etc.

(c) Reports of research results, identical to those we require under our research contracts, are provided for in our grants.

(d) Reports of actual expenditures by major categories of cost are required to be submitted annually and at the end of the grant period. Comparisons between these reports and the original estimates enable use to determine the extent to which cost objectives have been met. Selective audits are made to verify accurancy of reporting, and demands are made for the return of improper expenditures. Demonstrated fiscal responsibility weighs heavily in determining whether to continue support of on-going projects or new projects at a given institution.

h. In their negotiation and administration, we treat grants as a simple form of fixed-price contract providing for advance payment. Once executed, the grant amount is a fixed-ceiling amount. The grantee absorbs 100% of all costs incurred in the conduct of the research project in excess of the grant amount and returns any remaining funds at the end of the grant period.

CRITERIA FOR SELECTION OF GRANT OR CONTRACT IN AIR FORCE

1. Policy - It is the policy of the Air Force to use grants for the support of scientific research programs whenever the contracting officer considers such use appropriate.

a. If any of the following factors are present, a contract should be used instead of a grant:

(1) Any portion of the actual research services will be subcontracted (consultants are not considered subcontractors).

(2) A proposal is obtained through the formal solicitation process.

(3) The type of work requires close technical monitoring during the course of performance.

(4) Greater fiscal control through vouchering and audit is desired by the Government.

(5) The research requires security classification.

(6) More than 25% of the funds requested is for the purchase of equipment.

A comparison of our grants vs contracts:

AREA	CONTRACTS	GRANTS
PRICING	In this respect both contracts and grants are identical. Section XV of the ASPR is used in Pricing	
INSTRUMENT	Voluminous terms (25-40 pages) which are required by ASPR. Subject to frequent changes.	1 page, incorporating standard terms of printed brochure and grantees' proposal by reference.
WORK STATEMENT	Generally written by program manager from contractor's proposal, and then frequently rewritten by C.O. to put it into appropriate legal language.	Proposal is incorporate into grant by reference and serves as the work statement.
PAYMENT	Vouchers required to be prepared (usually monthly), and payment made after review, approval, and processing required by Government offices.	Payments are automatic, in advance, as required
FILE DOCUMENTATION	Must include determination of responsibility, contingent fee statement, D&F authorizing type of contract, etc.	None of these necessary Summary of Negotiations includes a determinatio that grant is the appropriate instrument for the particular procurement.
ADMINISTRATION	Considerable correspondence is required concerning matters where the C.O.'s authorization must be had before contractor may act.	Little correspondence necessary for grant administration.
PROPERTY	Must secure approval of facilities acquisition and must include a Facilities Acquired or Fabricated clause which lists the items authorized.	No facilities acquisition required. Listing of items in Grant required.

AREA	CONTRACTS	GRANTS
TERMINATION	Termination C.O. must be appointed termination claim submitted, and lengthy formal settlement agreement negotiated.	Unilateral, one page revocation.
CLOSING OUT	Great delays generally because final audit is required on each contract and because of the very long period before many overhead rates are established so the final voucher can be submitted.	Closing out may be completed as soon as final reports (technical, fiscal, patent) are submitted.

STATISTICAL INFORMATION

ARMY FY 76
(AROD)

	Number	Dollar Value
Grants	377	12.5 M
Contracts	110	7.4 M

NAVY FY 76

	Number	Dollar Value
Grants	64	.414 M
Contracts	2,478	189.47 M

AIR FORCE FY 76

	Number	Dollar Value
Grants	498	17.5 M
Contracts	433	31.7 M

"MAJOR ACQUISITION PROBLEMS, POLICY AND RESEARCH"

By Dr. Richard J. Lorette
The Systems Group
University of Southern California

Introduction

Just over five years ago, on July 13,1971, the Defense Department issued DOD Directive 5000.1, titled,"Acquisition of Major Defense Systems." Under the new directive, responsibility and authority were to be decentralized to the maximum extent. The DOD components would be responsible for identifying needs and for defining, developing and producing systems to satisfy those needs. The Secretary of Defense would make the decisions on program initiation, while Development Concept Papers(DCPs) and the Defense Systems Acquisition Review Council(DSARC) would contribute to and support the Secretary's decision-making processes.[1] In spite of the dedicated, sincere efforts of exerienced, competent people throughout the DOD, to implement the 5000.1 directive, fundamental, critical, familiar problems continue to frustrate our best attempts to acquire major defense systems.

Outline of the Paper

In this paper, I shall:

- review briefly the problems that led to the new directive,
- attempt to evaluate the success of the directive in resolving those problems,
- point out potential, related research topics,and
- suggest we should consider introducing a new approach to the acquisition of major systems.

After a short discussion of the problems, past and present,I shall try to answer these questions:

1. In summary, what have been our major concerns(problems) during the last 10 years?

2. What have we done to lessen or eliminate these concerns?

3. Have the means we've taken to accomplish our ends been effective?

4. Where we've fallen short, what do we think were the causes?

5. Can research make a contribution that would be cost-effective compared to alternative uses of our resources?

6. How can we avoid the difficulties inherent in the research operations of DOD?

7. What should be the focus of a major research effort directed at the acquisition policy for major defense systems?

The final pages of the paper will describe a new concept for acquiring major systems and will assess, in a short discussion, its impact on the current procurement management system structure.

Problems of Acquisition,1960-1966

A number of serious problems engaged the attention of our procurement experts in late 1966-early 1967. The F-111A/B(TFX), a multi-billion dollar joint Air Force-Navy program, had rarely left the front pages, it seemed,since the controversial decision by Secretary McNamara in 1961, to build one plane to meet the needs of the two services. That prolonged decision process was followed,in late November 1962, by the selection of General Dynamics as the prime weapon system contractor. Again, media headlines reflected a heated struggle within the Department of Defense, this time between DOD civilians and military authorities-who decided the Boeing design would produce the better airplane at the least cost-and Secretary McNamara-who cited a potential $1 billion savings that would result from the"commonality" features of the General Dynamics proposal.[2]

During the last part of 1966 and the first half of 1967, the F-111 Program Director, Maj. Gen. John Zoeckler, was faced with overpowering difficulties. They included, but were not limited to, the following:

- the Pentagon admitted that the F-111B's Phoenix air-to-air missile estimate had risen from $137 million to $258 million, with many guidance and control problems still unsolved,[3]

- the New York Times was insisting that the F-111A(Air Force) and F-111B(Navy) would probably have no more than 40 to 50 percent commonality(as opposed to the estimated 83-84%),[4]

- engine compressor stalls and losses of power under certain flight conditions were delaying Pratt and Whitney,the engine supplier,

- the aircraft weight - perhaps 78,000# delivered- would be well above initial(55,000#) and revised(64,000#)estimates,[5]

- unit costs for engines(2 per aircraft) had risen from $300,000 each to approximately $750,000 each between September 1962 and December 1966,[6]

- and Senator McClellan had ordered yet another investigation of the TFX(F-111).

If we accept for now that the problems of the F-111A/F-111B are typical examples of those encountered in other systems of that period, I think we would agree that the most serious general problems included:

1. Costs per unit(delivered) were above initial estimates and well beyond acceptable growth increments.

2. Failure to foresee potentially serious technical problems resulted ultimately in systems performance falling short of the initial approved design objectives.

3. Proliferation of changes and modifications during development and production, and after delivery, pushed total costs above expectations.

4. Overall, fewer total systems were delivered later than programmed to meet potential threats.

5. Along with continuing criticism from the Congress, a growing credibility gap was developing between the military services and the Executive Branch.

6. Inflationary spirals and materials shortages (caused partially by the demands of the war in Southeast Asia) progressively deprived the military procurement agencies of required buying power.

In fact, increased costs (experienced or forecasted) to acquire major systems and sub-systems were a factor in almost all of the criticism directed at the Department of Defense and Military Departments. It was equally apparent, however, that performance objectives had been reduced, schedules extended and quantities delivered significantly cut.

"We're All In The Same Boat"

The F-111A/F-111B was just one program. Many of us are familiar as well with the: GAM-87A Skybolt, which was cancelled following a successful B-52 launch of the ballistic first stage (hundreds of millions of dollars had been expended); the GAM-77A Hounddog, which was still not meeting it's accuracy goals years after it went into service with the operational fleet; the C-5A, which had cost overruns over a billion dollars and is today suffering from wing problems which affect the duration of its service life. There have been many other programs with similar problems in the Air Force history of the past twenty years. Unfortunately, these problems are not limited to one service. We can refer to programs where our compatriots in the Army were disappointed by program performance - consider the Gamma Goat, MBT-70, and M-16 Rifle, for example. Many of us are also probably aware that each year, when the newspapers have printed the list of very, very large military cost overruns, the Navy ship programs took a back seat to no one.

Yes, the problems of large military acquisitions were common to all, but that means each can benefit from the experience of the others. Let's look now at what has happened in the last five years, since DOD Directive 5,000.1.

Acquisition Problems, circa 1971 to the Present

What was the environment of weapon systems acquisition in 1971, and what were the problems, four to five years after the bitter debates surrounding the F-111 and C-5A? Deputy Secretary of Defense Packard said, in late 1971, that large cost overruns and other evidences of poor management by both the military services and industry had contributed to a growing anti-defense attitude in the country. He said that we weren't sure we needed the capability a proposed system was to provide in five to ten years. When we were sure, he continued, we couldn't achieve real requirements because of over-estimates of the state of technology.Furthermore, development- and cost growth- often continued long after a program should have been terminated. One of his final comments was:

> "...major acquisition programs will turn out better only if they are managed better. There is no better way to improve the management of a program than to get a better manager and give him the responsibility and authority to manage." [8]

His 1971 assessment fairly closely duplicates problems noted[9] in the 1960-66 era, and included : cost overruns, poor management, criticism from other sectors, "spongy" requirements, over-estimates of technical know-how, and ineffective programming decisions.

The climate has not changed appreciably since 1971.It was written in July 1975, for example, that we'd paid more than we should have for unneeded performance gains in the F-14, C-5A and Cheyenne helicopter.[10] Dr. John J. Bennett(Acting Assistant Secretary of Defense, I.&L.)inferred we were still having problems controlling anticipated costs for weapons under development.[11] In June 1975 Mr. O.C. Boileau(President of Boeing Aerospace Company) said,

> " The defense landscape is littered with programs that have failed to live up to expectations. In most cases, the ultimate performance was acceptable but it cost more than originally estimated to obtain and maintain that performance." [12]

What really disturbs me, more than the above, is to read <u>in today's newspapers</u> predictions of problems to come in proposed new programs. Consider -

> " A House Armed Services Committee has concluded that Secretary Rumsfeld's decision to turn the proposed U.S. XM-1 tank into a U.S.-West German hybrid would delay production,increase costs and reduce combat capability." [13]

Summary of Major Concerns

What have been our major concerns(or problems) during the past ten years? [14] Limiting our discussion to the process of acquiring major weapon systems, we might over-simplify somewhat and list the following questions, suggesting that they describe sufficiently our most difficult problems: (not necessarily in order of priority)

1. How can we accurately forecast, 5 to 10 years in advance, what one production unit(or even the total system)will cost?

2. How can we avoid design and planning errors(of omission and commission) prior to production go-ahead and thus avoid subsequently required changes and modifications?

3. How can we determine accurately the required performance and schedule parameters of a proposed system when intelligence sources cannot define precisely possible future threats?

4. How should we respond to criticism(WHICH WILL CONTINUE) of our management efforts in a manner that will eventually close the credibility gaps encircling us?

5. How do we improve our management efforts, particularly those affecting the determination and control of acquisition and operational support costs?

Agreed, there may be many other matters that have concerned us, or perhaps should have concerned us. However, I am convinced that major inroads against those five would lead to a more effective,less costly defense; I do believe we have been on the right track. How did we proceed,then,to meet the challenge of simultaneously -

. fighting an unpopular war in Southeast Asia,
. contending with nearly unprecedented inflation,
. responding objectively to critics from all quadrants,
. resolving acquisition problems that have not changed since WWII?

What Have We Done to Alleviate These Concerns?

Starting with Mr. Packard's May 28,1970 memo, we focused on improving management practices, especially in the System Program Offices, and stressed-

- cutting out numerous layers of authority,
- reducing directives and regulations to a minimum,
- encouraging initiative and innovation,
- putting more capable people into program management, and
- giving them the responsibility and authority, and
- keeping them there long enough to get the job done right.[14 A]

In terms of acronyms, that refer to management systems and techniques, and naming only a very small number of those being employed, we have tried (or are trying):

LCC	C/SCSC
DTC	PERT
DSARC	PERT-Cost
CAIG	"Should Cost"
CER	PIECOST
DIDS	CATVA

We're emphasizing change controls, contractual incentives,warranty provisions, personnel selection and promotion, and parts standardization.Finally, we've tried perhaps every conceivable type of variation of contract and have followed the philosophies of: "buy-before-fly," "fly-before-buy," "total package procurement concept," "two-step procurement," and today's marriage between Life Cycle Costing and Design To Cost.

In many respects, we seem to be looking for the panacea - while insisting all the while that we know there is none. I don't think we believe that. Our actions and words belie our words. We are searching for that remedy for all ills. Many of us, some new to the business and some old timers, do not recognize - or will not accept - the intricacies and inter-relationships of the tasks we're engaged in. We want the key. "I have it," says one, "it's modeling." "No," says another, "it's competent personnel - or credibility - or life cycle costing - or the manager - or (pardon me) procurement research - or forecasting - or standards - or incentives." The way I perceive it, there may be many keys to a few safety deposit boxes that may provide us with a few dollars now and then, but there is no master key to the gold reserves at Fort Knox, that will guarantee our future security! And we should stop thinking that we have found it today or may find it tomorrow or next week or next year!!!

What have we accomplished with all our work?

Have We Been Successful?

Frankly, I don't know what all our efforts have accomplished, and I do not think anyone else knows either. So much is going on all at once, it's very difficult to judge accurately the cost saving or other benefits of any one or all of our well-intentioned activities. I am not even certain that we have set up checkpoints, in order to check progress against objectives and costs, for most of the management systems that we required the contractors to use.

Baumgartner wrote that C/SCSC was "alive and well" in 1974[15] and being implemented at a lower cost than originally estimated.

Gen. Etkin, of the Defense Electronics Supply Center (Dayton, Ohio), reports considerable success for the Navy's Standard Electronics Module (SEM) program through increased commonality percentages, which led to savings in initial spares provisioning.[16]

Overall, however, I don't think we really know whether individual efforts are succeeding. Personally, I suspect we're failing to solve our major problems.

Why Haven't We Succeeded?

One reason is that we're still in too much of a hurry. Government analysts frequently have insufficient amounts of time, during source selection, to validate contractor proposals.[17] In our haste to get into production, we give too many R. & D. problems a surface patch.[18] Secretary Packard said,

> "As I reviewed program after program in the spring of 1969, almost all were in trouble from a common fault-production had been started before engineering development was finished. I am sure you all know all about this problem."[19]

Maybe we all knew all about it then, but we weren't able to control this deficiency. It appears that perhaps, if we're aware of the weakness today, we still can't control it.

Some portion of the "undue haste" problem is caused by program advocates' honest beliefs that their programs are each absolutely vital to the survival of the United States. It maybe that you need that sort of faith , and the enthusiasm it generates, to survive as a Project Director or Project Manager in the military or in industry.

Yet those of us who are not that involved know very well that this nation and the free world would have survived without the F-111, F-5,F-14,F-15,F-16, F-18, C-5A, and so on. Ignoring hindsight, we also know that we shall survive in the future - even if we're involved in WWIII - without many of the programs on the drawing boards today. One program could very well be critical but not all of them. Not many people would say that the Sherman tank of WWII was superior to the German Tiger tank,but 30 or 40 Shermans were a handful for a dozen Tigers. The ME-262 flashed through our bomber formations over Europe and was gone before P-47s and P-51s could complete a 180-degree turn, but again, numbers and American productive capacity made the difference Spitfires shot down V-1s, and"Pappy" Boyington's experience made the F-4U, though less maneuverable, a worthy opponent of late model Japanese Zeros.

Some programs are truly vital to our national security. For example:

- What about a new class of undersea surveillance systems that would make it possible to locate submerged missile-launching submarines at great range AND with sufficient accuracy to target them?

  Yes, that's worth a pretty high priority, on my list.

- Is it possible to develop a space-related use of high energy lasers that will make it possible to destroy our vital satellite network and strategic deterrence surveillance capability?

  If it is, that's pretty high on my list.

- Is it possible for an adversary to sign nuclear test ban treaties and then covertly test new weapons without our knowledge?[20]

  If it is, then designing a system that would detect those covert tests, would be on my list.

But beyond programs , such as the above, which really do affect our future survival, we should take the time to develop the systems in a way that lessens the likelihood that we'll be surprised in production by problems we failed to solve in development. Allowing more time for conceptual studies, negotiation, source selection and review processes is "long run" insurance.

Some questions cannot be answered now, because we don't know enough. We must have knowledge of airframe and wing structure if we are to forecast modification dates, replacement dates and costs, but "... unfortunately, this knowledge is not available during preliminary design stages ..."[21] So there is a limit as to how early we can hope to enter the cycle and forecast accurately what life cycle costs will be. Until we've actually built and tested the C-5A wing, there's no way that you can produce valid estimates of the year when it will have to be replaced or the related cost.

Medalia, writing in the Naval War College Review, stated, "Intelligence, on which we base decisions on what we want, is imperfect..." [22] Therefore, even though as a rule, we are not really sure of what we'll need or when, we prepare detailed RFPs, trying to explain our indefinite needs to the contractors. They also do their very best, trying to demonstrate that they really do understand what we want - and can build it for us. Even knowing exactly what's expected isn't going to guarantee accurate cost estimates. We just cannot predict the future - there are ~~too many~~ unknowns. The sooner we face that fact of life, the better off we'll be.

Can Procurement Research Help?

If those are the facts, and we're still talking about ways to reduce - not eliminate - but reduce cost overruns, schedule slippages and performance shortfalls, can research help?

Yes, research can help in at least one very important area. It's still not a panacea, either; it's not the key. But there is a direction that perhaps is as worthwile as a ringful of keys, and that is research into the selection process for major defense systems. I believe it's time that we asked, "What other means can be employed to select our prime contractors for the major defense systems?

Medalia mentioned a nation's "style of military procurement" when he wrote:

> "Technology develops and technical decisions are made within the context of a nation's style of military procurement... this style is independent of technology; nations have different styles. But, for each nation, the style links technical progress and the political system, strongly affecting both." [23]

We have to look beyond our myopic day-to-day obsession with details of management control and reporting systems and begin to think about our style and about the conceptual relationships that surround the basic acquisition process as we practice the art of acquisition. What is our philosophy? How is it linked to the political system ? How is it linked to our economic well-being? How is it related to our democratic traditions and religious upbringings? If there are such linkages, are we aware of their influences?

Obviously, the Russians produce some fine equipment, following philosophies quite different from our own.[24] So do the British, and so did the Japanese.

Our manner of selecting contractors mirrors our belief in the free enterprise system; our "style" reflects our dedication to democratic traditions, capitalism, competition and fair play. It is surprising, therefore, to read a quote by the President of one of our most successful aerospace companies, a company whose success over the years has been achieved by "playing the game" according to the rules of our style:

> " Contracting parameters must be set up so that price is not a competitive item." 25

I think we have to listen when a leader on our team of defense contractors suggests such a drastic change in our way of doing business.

Is it possible that our use of competition in source selection is a mistaken, unnecessary and disabling application of capitalistic free enterprise?

Potential Problems of Research Within DOD

Questioning the use of competition in the acquisition process is serious business. Alternatives are not stacked neatly in piles awaiting our call.

We can discover new and different approaches that will relieve many of our difficulties; further, those concepts can be converted into policy statements with the required operating procedures designed,instructions developed, and implementation guidelines distributed in the manner of other major procurement policy revisions in years past. But first we must plan the research that will support the change.

In this instance, the "how" of the research activity is as important as the "what." Every possible consideration must be given to ensure that we plan what it is we are intending to investigate.If we allow ourselves to be rushed into what appears to be a reasonable research plan, without insisting on a complete analysis of all factors, we'll find ourselves looking at a pile of reports, unable to say for sure what we've learned. And the DOD will be asking again,"What has this expenditure of time and resources produced? We're not sure what it all means."

All the routine steps of any well-thought out systems analysis apply in this research project as in any other complicated undertaking. We must take the time in the beginning to clearly identify what it is that we're trying to do - in other words, what's the objective? Priorities have to be established and ,to the degree possible, objectivity guaranteed in all tasks ; that includes the design of the research plan, data collection methods, analysis of the data and study recommendations.

It's absolutely essential that we decide in advance of the data collection and analysis, what results might be obtained and how specific results are to be interpreted. Also, we must have the agreement of others,interested and perhaps sponsoring our efforts, as to what the possible answers will be interpreted to mean.

Attention to the composition and management of the research teams is very important. We must be confident that the team leaders and members have expertise in the disciplines required by the nature of the study. "Instant experts,"who read a few articles in recent publications,must not be allowed to artfully insert themselves on the teams by glib use of the current "buzz words." We should demand that all researchers and the team leaders produce credentials and confirmed outstanding products of previous individual efforts. I suggest that for a study of the consequence proposed by Mr.Dale Babione [25A] and Mr. Boileau (Boeing), we must look as closely at the management and team composition as we do at the management of a costly equipment acquisition. Any other attitude will find us concluding at the end of the study that many dollars have been wasted to produced a marginal, if not useless, report.

One problem we should be particularly wary of is an off-shoot of the "we invented it here" syndrome. We think we're the experts; we think we know what the problems are; possibly, we think we know what solutions are available and even which ones will succeed. Yet, if we've selected competent,knowledgeable researchers, they are experts,also. They may think they know something about our problems and might even believe they have some equally worthwhile ideas to contribute.

I have a colleague who delights in saying,"If we knew what we were doing, we wouldn't need research." While that may be a bit strong in this situation, it is still true that we probably wouldn't be paying (with dollars, time or resources) for research, if we knew the answers or if we had the time to look for them ourselves.

There is another potential area of difficulty in research performed within the Department of Defense. We must try to avoid putting unnecessarily heavy pressures on the objectivity of in-service(whether Air Force Academy, Defense Systems Management College, Air Force Institute of Technology,Naval Post-Graduate School, Army Logistics Management Center or whatever) researchers. I believe it is expecting a great deal to ask an officer or civilian, whose future career success depends on the opinions of his superiors both immediate and throughout the defense hierarchy, to report that the current, very highly regarded management control system, or acquisition philosophy, or contractual innovation is not effective and should be discarded. Such people are available in the military and should be put to work.

We must try to secure the services of objective,competent,dedicated and fearless researchers.

The next "must" is that we are defeating our own purposes if we don't do our best to give any reasonable suggestion its "day in court."

Let's go on now to what are the alternatives to competition that we'd want to direct our research toward, not forgetting that some portion of the effort must be aimed at discovering entirely new frontiers.

Alternatives to Competing Source Selection

Putting aside for a moment the question of whether we'd want(or be able) to employ a method other than competition, are there even any alternatives? We could say, I suppose, that "fly-before-buy," "buy-before-fly,"&"total package " were major systems acquisition concepts or philosophies, but they all employed competition in the selection process and really aren't alternative to competing selections of the prime contractor. Except for the option that I'd prefer to postpone mentioning until I've laid some additional groundwork, aren't the only other choices "far out" ideas like:

- a lottery,
- random numbers,
- or rolling dice?

Surely, Mr. Boileau of Boeing was not envisioning one of those as a possible replacement. Perhaps Lockheed, Boeing,General Dynamics,McDonnell Douglas, Grumman and the other top defense contractors in the aerospace field could take turns - that's what they appear to do anyway.

Whatever we try to do, if it's really new and different, we're going to be buried with economic, political and philosophical objections; we'd best be prepared to argue persuasively in favor of our proposal. Having in hand several, well-documented research-generated reports, proving the failure of the current source selection process, would be a necessary step in advanced preparation for the struggle..

If there is a better way, would it be worth the struggle?

Benefits of a New Approach to Source Selection

Still keeping my proposed innovation "under wraps," let's discuss some of advantages it must have, if it's going to be worth the trouble. I think it would be wonderful, if our new approach could do these things:

?1. Eliminate the need for contractors to deliberately underbid (or to believe they must underbid) in order to win a contract,

2. Decrease drastically the time between DSARC I and IOC by reducing the amount of time required to select the prime contrac- for the next major award,

3. Reduce the millions of dollars of "out of pocket" costs involved in preparing RFPs, in preparing responses to RFPs and in evalu- the responses to the RFPs,

4. Allow us to retain the effective management systems and techniques that we have developed and implemented, while discarding those that don't meet our needs,

5. Assure the survival of a large enough defense industry resource base to protect our long-run national interests,

6. Motivate the contractors to move toward more realistic bids while increasing our own ability to assess accurately the validity of their estimates,

7. Eliminate a significant portion of the drain on the contractors' and government personnel resources which are required to prepare, respond to, and evaluate RFPs,

8. Encourage all responsible contractors to have a part in providing the system or equipment that their capabilities will permit,

9. While guaranteeing 8. above, still monitor carefully the contractors' performances so as to assure the American taxpayer that his dollars are buying the best available defenses at a reasonable cost.

Why are we wasting our time in this line of reasoning? Don't we have to compete awards?

How Innovative Can We Be?

Do we have to compete these selections of prime contractors? The ASPR, Public Laws, other legislative and executive branch directives, and probably many judicial decisions require that we do - - - today.

Let us suppose that research proves that competing the selection of our major defense awards has not been effective in achieving our objectives. Suppose we were to find that competition for specific contracts has been one major cause for cost overruns, because the potential rewards are so great that the contractors "go overboard" in their frenzied efforts to find the believable number - the figure that will win the contract? If they think their survival is at stake, can we blame them?

We must not allow our thinking - actions "Yes," but not our thinking- to be bound by current rules, regulations, decisions or directives. Laws have been changed, the ASPR has been revised thousands of times, and Supreme Court decisions have reversed previous Supreme Court decisions. So let's not be limited by what appears to be possible in today's environment!!

Okay, we agree that rules can be changed. The important question now is- is there reason to believe that competition for specific contract awards is a major contributor to our problems?

Could Competition Be A Real Cause For Many Overruns?

I believe it is... as we employ it.

With the pressures removed to win the contract, our prime contractors would submit their estimates of what they really believe the program will cost. Their considered best judgements, and there's a great deal of successful experience behind those judgements, are modified considerably today by:

- reductions considered mandatory if the contract is to be won.

Those reductions are based on:

- industrial intelligence sources that reveal "ball park" approximations of what competitors are likely to submit as the price,

- and educated guesses as to what Congress and the Military Services are likely to "buy."

It's true, I think, that receiving bids from two or three contractors in the past has allowed us to compare their estimates with our own internally derived calculations.If we were close. we were able to feel somewhat confident about the possible range of the eventual cost.

But without competition, in other words, with only one contractor, we could stop worrying about overruns caused by deliberate underbidding, and that would be a step forward. Now, the problem might become - how do we prevent him from charging us more than a fair price? We are already working in several directions, trying to improve our estimating capability, and whether he's estimating high or low doesn't make that job any easier. Renegotiation did seem to collect quite a few dollars , when "after-the-fact" records provided specifics on exactly what various activities did cost.

Instead of putting so much time and effort and dollars into attempts to prevent the contractors from "buying in," why don't we remove the motivation for them to underbid in the first place?

American Tradition Demands Competition

Can we have competition and yet not have it? Could we satisfy the demands of our capitalistic, free enterprise economy and have competition in the acquisition of major defense systems but not in specific contract awards? Can we have the benefits we claim competition produces without having competition in the source selection process?

I think we can. We used to compete with brochures in our "buy-before-fly" days; now, we are attempting to compete by testing the hardware and awarding contracts based on the results. We're still competing but the object has been changed from a brochure to a test report. That's moving again in the right direction.

But we're still unnecessarily limiting our options by insisting that the competition be be conducted relatively simultaneously - one contractor against another or against two others - in a fly-off for this system this week. Or we're asking two or three contractors to submit proposal that will prove one's predictions of Life Cycle Costs(instead of the acquisition price alone) are lower and more believable than the others'. But, again, they're competing now for this contract with the award to be announced after analysis of their proposals by objective, experienced teams. [26]

Contractors Are Always Competing

Aren't the major aerospace contractors,for example, always competing even if they don't happen at the moment to be in a run-off for a F-14,F-16 or F-18?

Of course, they are competing in the commercial aircraft business and in the international markets. But I'm asking if they aren't always competing for military business?

I see them as being in competition all the time, but it's general - not for a specific contract. They are competing - or have been in the past couple or three years - to have their installed C/SCSC systems approved; isn't each one trying to prove that, regardless of what weapon system might be involved, his procedures and methods for defining Life Cycle Costs or Design To Costs are more reliable than the other guy's? Isn't it competing when they try to convince us that their selection of sub-contractors (which could be a competition process of its own) will result in a more cohesive team than others being offered? Aren't they always competing for designers, engineers and managers? For that matter, isn't he competing when he is developing and producing the system that he won in last year's big award? He certainly is, because he knows that on-going program is the best opportunity he'll ever have to show that he gets results - more performance, lower costs and on-time deliveries.

It's my opinion, therefore, that they're already competing in the best tradition of our free enterprise system, and competing during source selection merely causes problems we don't need, expends millions of dollars unnecessarily that we **do** need, and unquestionably provides more opportunities to be on the front pages than anyone's desire for notoriety would require.

Award Rotation Concept

It's time now to describe an alternative that I consider deserving of serious deliberation. I propose that we formallize what is the reality of source selection process for the prime contractor and permit competent, capable contractors- wishing to participate - to take turns on being involved with major defense system contract awards.

I think that many experts in Procurement today, and last month, and five years ago, would concede that Boeing could probably have performed as well as Lockheed on the C-5A and as well as General Dynamics on the F-111. Wouldn't McDonnell Douglas have done a satisfactory job on the C-5A and Grumman on the F-111? How about Hughes, Rockwell or LTV, instead of Northrop, on the F-5? As a matter of fact, I believe we could count on organizations, like Northrop, Martin-Marietta and LTV to form prime-sub or associate-associate arrangements that would enable them to produce the F-14 or F-15!

We'd have to admit that the selection process did not avoid major problems with the F-111 and C-5A and with many other programs of the other services.

Why couldn't we classify our defense contractors according to several criteria such as: past performance, assets, size, areas of expertise, location, etc. and then just rotate each company in turn, matching the desired weapon system with one contractor from the group (or class or commodity category or whatever we'd call them) deemed capable of developing and/or producing the proposed system? I'd place companies like Boeing, McDonnell Douglas, Grumman, General Dynamics and Hughes in the top aircraft grouping; they were all in the top five in terms of dollar awards in FY 1975 (between 1 Billion and 1.5 Billion).[27]

Similar groupings of contractors could be developed for contractors who build ships, tanks, helicopters, computers, electronic systems and other major systems.

Is Award Rotation Possible?

Would it be possible to set up a system to rotate awards? Would such a system reduce the numbers of problems we've had in the past?What would be the benefits and what would be the disadvantages? How many of our current management systems, that many people have worked very hard to design and install,would have to be revised or discarded outright?

Let's try to answer some of these questions without the benefit of in-depth research which would be required.

First, is it possible to rotate the major contract awards with responsible contractors taking turns,as RFPs were released for the development and production of weapon systems, within their acknowledged areas of competence and resources? It is possible if they are willing and if the laws would permit. We know who the big companies are,and we have a pretty good idea as to what size program is within the capabilities of the various companies. In line with the"participative management" principles followed by Secretaries Laird, Packard and others, we might even ask the contractors what type awards they wish to be involved with and when.

Second, what about a corporation,new to the business, or one wanting to move up into the next higher commodity grouping? We do have the knowledge and experience to establish the threshold criteria for each of the commodity groupings. In fact, part of the selection process today(perhaps even the decision as to which companies should receive RFPs)involves a serious study of the particular bidding organizations ability to complete the contract being competed. Isn't that a big part of the RFP evaluation process - does his response to the RFP indicate that he understands our requirement and can fulfill the stated objectives? Under the proposed Award Rotation Concept,all potential prime contractors for major awards would be evaluated by a formal process and placed in the appropriate commodity grouping or class.

Third, speaking of RFPs, would we still use them? Absolutely! We can call them something else, but there still must be a vehicle for communicating to the contractor what we want. We still must clarify, within the limits of what is reasonable in time,resources and dollars that we're willing to devote to RFP preparation, what it is that we are asking the contractor to do. Of course, it might be easier than it has been in the past,because we know who the next one in line is and could even start working closely together-much sooner than now-on working out the unknowns,risks,and uncertainties. The old prohibition, against writing the RFP so that it's tailor-made for only one contractor, can be forgotten. In ARC, we want to tailor the requirement -without unnecessarily trimming the specifications - to the capabilities of the supplier.

That's good - we retain the part of the organization that builds RFPs.

Fourth,What about the contractors - must the next one in line respond to the RFP? Certainly. How else can we tell what the other guy wants and intends to do? The process now is a continuous updating and revision of the technical, schedule and cost objectives, as we gain more knowledge about what the state-of-the-art will permit and what risks we're willing to take beyond that point. A major difference with ARC would be : only one contractor has to prepare a response, we reimburse only one for proposal preparation(if that's agreed to), we have to evaluate only one, and we work with only one in hammering out details. I'd judge we could have saved many months,perhaps a year, in the F-111 and C-5 cases, if we'd been able to skip the source selection processes.

In part, his response to the RFP could be much more candid. No more of this, "Whatever you want, I can do it." Knowing he has the contract, he'll be much more willing to admit areas of weakness and to seek help. The contractor could question seriously the desireability of certain design parameters and might even suggest that our design-to-cost estimates are way off.

Fifth, what if the Government and the Contractor can't agree on what is to be done or on the schedule or costs - does the contractor lose his turn? I feel that the process of jointly preparing, responding to, and evaluating the RFP will still consume months. It would not benefit the Government to have wasted all that time, and it certainly wouldn't profit the Contractor, if failure to agree meant losing his turn. I believe both would be induced to negotiate their differences in good faith.

In addition, if the Contractor believed that the system being proposed was beyond his capabilities , within the limits being described by the Government, very early in the process the contractor would be required to indicate the scope of his involvement. He'd be asked to state a preference for:

- Being the prime contractor,

- Being one of a pair of primes(or Associates) with the next company in line - whose identity would be known- being the other Associate,

- Being a major - or the major- sub-contractor to the next company in line, that company being prime,

- Being one of many sub-contractors to the next company in line,

- Being allowed to defer any participation,without prejudice, until his next turn.

Sixth, doesn't it appear that there might be a little constraint on our free enterprise system , with this "take your turn" procedure? Wouldn't it prevent the biggest,best,most profitable company from having a chance at all the awards? Would we be depriving our nation of the potentially tops in quality,reliability,management expertise, etc.? It's true, everyone would not have an opportunity to win every contract. But everyone doesn't have a chance at every contract today. There are significant political,economic, and public interest inputs in the award process that prevent pure competition. However, I believe that most of us consider that appropriate in a general,total approach even though we may feel at times that the Government goes a little too far in using its military contracts as a vehicle to further social goals.

Seventh, How many of our present management methods and systems would have to be revised or eliminated? Everything following award of the contract would still be needed. The DSARC process, at least DSARC II,IIA and III , would still be used. Yes, Life Cycle Costs and Design To Costs still make sense as do PIECOST,CER,C/SCSC,DCP,DIDS,MTBF,CATVA,CAIG and all the rest.We still would want warranty provisions,parts standardization,contractual incentives,change control, competent personnel, and so on.

Eighth, would a contractor be awarded the next contract, as his turn came, if he had failed to perform satisfactorily on his last award? We evaluate contractors today. A miserable performance can result in a contractor being removed from the list of those authorized to receive RFPs. It may be, under the proposed Award Rotation Concept, that a contractor will try harder because, if he misses a turn, it may be a long time before his turn comes up again. Then again, depending upon the area of his failure, it could be decided that he should not have the opportunity to be the prime on his next turn but would be eligible to be an Associate or major sub-contractor. Today, if he loses out on one selection, he can tool up to bid right away on the next.

It may be that one major advantage of ARC is that there would be time between turns for the Government to be evaluating the contractors' performance on systems currently being developed or produced. So we'd still have competition among commodity group members working on different programs, because now he's competing against his program's objectives to assure that his next turn will be his for the asking.

A contractor who was utilizing all his capacity in private commercial or international military business would have to participate in ARC at some level or would be dropped to a lower grouping, after a number of years of not participating and not being evaluated by Government.

Ninth, would rotating awards for major contracts contribute to more steady employment for individuals and more personnel stability within companies? I believe it would. Contractors would know when they were next in line and could plan personnel requirements to a greater degree than today. The days of hiring large groups of engineers to prepare proposals, only to get laid off when the contract was lost, would be over. Also, we'd see an end of the situation in which a small cadre is asked to prepare the proposal with the "carrot-at-the-end-of-the-stick" being, "If you win the contract, we'll give you more people." It's that sort of proposal preparation that produces incomplete, inaccurate work and subsequent changes, modifications, and cost overruns.

ARC would encourage contractors to start planning personnel actions early, building the teams of managers and engineers in an orderly, efficient manner.

Summary and Conclusions

The purpose of this paper has been to suggest the need for serious inquiry into the adequacy of existing methods for establishing requirements, selecting prime contractors, and controlling costs. In seeking answers, I think we must ask:

- What is competition?

- How should it serve us in the acquisition of major defense systems?

- What's the best means for helping our managers to put competition to work in the fight to reduce overruns,schedule slips, and performance shortfalls?

My intention has been to cast doubts on old ideas that have been accepted too readily as firm conclusions when, in fact, they should have been only departures for further exploration. We seem to have been too willing over the years to put into practice every new fad that comes along.Some accuse us of "managing by slogan."

I think, throughout the total acquisition process, it may be that our most serious defect - and there should be a stronger word than "defect" - has been obsessive, rash haste. We don't allow ourselves enough time whether we're defining missions, estimating costs, or developing hardware. As a result, the old problems of cost overruns, schedule slippages, and technical performance shortfalls are still with us. Why? Likert said it well:

> "Haste is self-defeating because of the anxieties and stresses it creates. There is no substitute for ample time..." [28]

A solution in the short run is wherever possible to allow more time, particularly in those phases of the process that precede the decision to go into full-scale production. We must also apply the "tried and true" principles of:

- assigning competent personnel to the SPOs and keeping them there,
- allowing more time to prepare, respond, and evaluate RFPs and responses to RFPs,
- giving our managers responsibility and authority and cutting out unnecessary, intermediate review levels'
- encouraging, at all levels, initiative, innovation and a questioning attitude,
- reducing the number of regulations and directives that sap the strength of the SPOs and frustrate their aggressive leadership.

We are doing many things well and must continue those efforts.Meanwhile, we should not allow day to day involvement with routine,continual cost reductions concerns, as important as they are, to distract us from the search for that "new and different" approach to the overall process of selecting contractors and acquiring major defense systems. Not too far from your attention to the daily "fire fighting" should be questions such as:

- How would we acquire major systems if we could do as we pleased?
- What research should be undertaken to improve the total process?
- Why would a proposed new method be an improvement over today's approach?
- How can we sell our ideas to those in the decision-making positions?

It's up to those of us at the working levels; we have the experience, the knowledge, the motivation, and the drive. I ask you -

HOW CAN WE TAKE THAT GIANT STEP FORWARD?

Footnotes and References

1. "Major Defense System Acquisition Policy Announced", Defense Industry Bulletin, Fall 1971, p. 1-2.

2. "The F-111B: Can It Do The Navy's Job?", Scot McDonald, Armed Forces Management, December 1966, p. 38.

3. "Pentagon Confirm Skyrocketing F-111 Cost", B. Price.

4. New York Times, June 7, 1966

5. "DOD Threat Clouds Future of Navy F-111", Aviation Week and Space Technology, November 1, 1965, p. 16.

6. Estimate #1 (Proposed System Package Plan, March 1962) to Estimate #8 (Program Budget Decision 370 Reclama, December 23, 1966) from unpublished dissertation, "The Relationship Between Pressures On The System Program Director And The Growth of Weapon System Cost Estimates", R. J. Lorette, June 1967, p. 213-221.

7. "McClellan Orders New TFX Probe", Washington Star, December 11, 1966.

8. "Defense and Industry Must Do a Better Job", David Packard, Defense Industry Bulletin, Fall 1971, p. 3.

9. Lorette, op. cit., p. 335-372.

10. "Evaluating Performance and Cost by Computer", Robert F. Williams, Defense Management Journal, July 1975, p. 9.

11. "Comment", Dr. John J. Bennett, Defense Management Journal, January 1976, p. 1.

12. "I Dreamed We Went Nowhere in Our Solid Gold Airplane", O. C. Boileau, Defense Management Journal, January 1976, p. 7.

13. "News In Brief", Los Angeles Times, September 24, 1976.

14. Perhaps a better question might be, "Have we been concerned about the right problems?"

14A. AFSC Procurement Evaluation Panel; New Check in Defense Systems Acquisition", Maj. Gen. Edmund F. O'Connor, Defense Management Journal, April 1972, p. 11.

15. "C/SCSC: Alive and Well", J. Stanley Baumgartner, Defense Management Journal, April 1974, p. 32.

16. "Standard Electronic Modules", Gen. M. Etkin, Defense Management Journal, July 1975, p. 47.

17. "Models a Key to Air Force Life Cycle Cost Implementation", Dwight E. Collins, Defense Management Journal, January 1976, p. 57.

18. Boileau, op. cit., p. 7.

19. Packard, op. cit., p. 3.

20. "The Role and Mission of DARPA - An Investment Strategy for the Late Seventies", Statement by Dr. George H. Hielmeier, Director before the Subcommittee for Research and Development of the House Armed Services Committee, February 20, 1976, p. I-5 thru I-7.

21. "Corrosion and Fatigue: Problems in Life Cycle Costing", Thomas K. Moore, Defense Management Journal, January 1976, p. 53.

22. "Congress and the Political Guidance of Weapons Procurement", Jonathan E. Medalia, Naval War College Review, Vol. 28.2, Fall 1975, p. 13.

23. Ibid.

24. Our pleasure at being handed a MIG-25 (Foxbat) at Hakkodate, Hokkaido, Japan in early fall of 1976 is proof that the Russian system is capable of producing equipment that is competitive.

25. Boileau, op. cit., p. 8.

25A. "Solution to Problems Through Innovation and Communication", Mr. Dale R. Babione, Defense Management Journal, July 1975, p. 2.

26. "Designing for Life Cycle Cost", William H. Boden, Defense Management Journal, January 1976, p. 29.

27. The top five (of 100), in terms of awards for FY 1975, were:

Boeing Company	$1,432,000,000
McDonnell Douglas Corp.	1,398,000,000
Grumman Aerospace Corp.	1,320,000,000
General Dynamics Corp.	1,280,000,000
Hughes Aircraft Co.	1,005,000,000

"Defense Department Lists Leading 100 Contractors for Fiscal 1975", Aviation Week and Space Technology, February 2, 1976, p. 54-57.

28. Rensis Likert, New Patterns of Management (New York: McGraw-Hill Book Company, 1961)

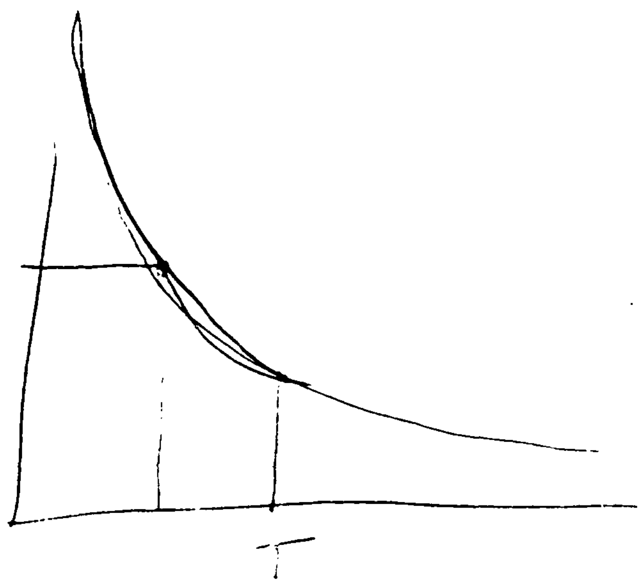
COMPETITIVE MISSILE PROCUREMENT

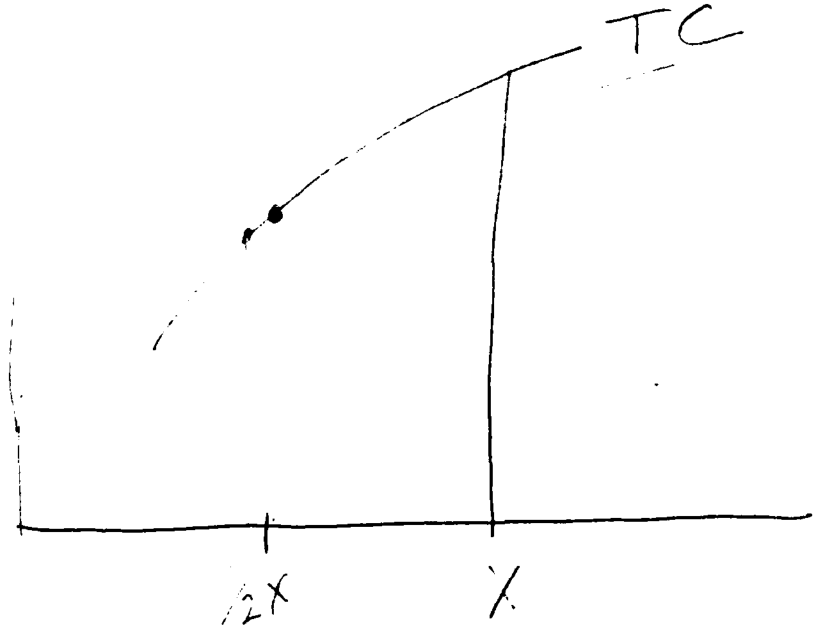
Traditionally, the development and production of the Army's Missile Systems has taken place in a sole source environment. There have been many reasons for this, including cost of development and the fact that once a contractor had developed the expertise, we have been reluctant to break away from him due to our requirement for quality and performance. However, we all recognized that cost savings could be achieved if the stimulant of competition could be injected into this atmosphere.

However, when dealing in sophisticated weapons systems, we obviously cannot go to the open market place with a set of drawings and specifications and have a great deal of confidence that the low bidder on price alone will be able to meet the Government's requirements of quality, quantity, and performance all within the framework of a rigid time schedule.

The optimum situation is to conduct competition among potential producers who have demonstrated an ability to produce a complicated system on schedule and in accordance with specifications.

Obviously, the situation dictates the location of or development of a second source in this historical environment, which has led to the developer moving on to become the sole source producer.


T


TC
½X
X

Ask [illegible] [illegible] Ta[illegible]

Assess Scale [illegible]

[illegible] the [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]tion

Lorette:

Al Muller

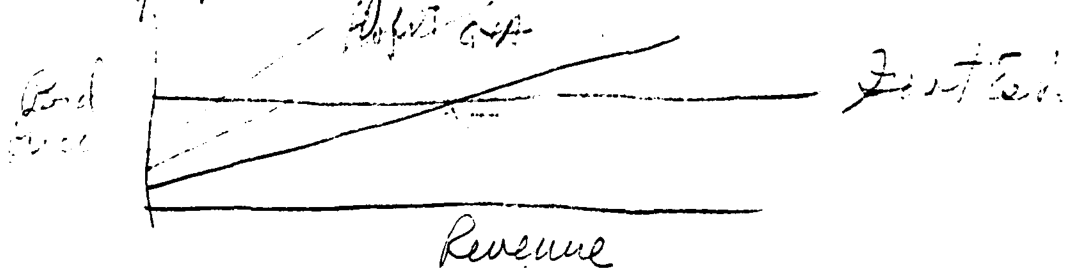
COMPETITION - Theory

Individual [illegible] make [illegible]
his own best interest.

Concept of revenue
- Basic Revenue
- Overhead - Defined? Don't understand/agree
- G&A - Estimated
- Profit - Relevant [illegible] Bond - [illegible]

Influences
- Business in [illegible]
- Labor mkt
- Location of work
- Contractor's experience there
- Nature and extent of competition
- Knowledge of market.

Bidding Technique



- DD 632 certification [illegible] relation to cost

Recommendations:
- Restudy of bills by Leverett Saltonstall in 21st Congress.
- Utilize these to make competitive negotiation preferred method.

[illegible] ; - Competition

- Objectives: ① Common Framework
  ② Identify Research Tasks

Process Orientation

Inputs		Process		Output
Competitive Conditions	→	Competition	→	Competitive Effects
① Identify Key variables		② Identify its characteristics, behavior traits		③ Identify Key variables

Forte - [illegible]
[illegible] - [illegible] the [illegible]
Mueller - Move to change input to [illegible]

Notes on presentation
Forte:
[illegible]

The US Army Missile Command (MICOM) has developed a method which utilizes tools available in the procurement workshop to obtain the benefits which flow from having two fully capable sources compete for the production of the same missile. The method has now been used three times and the Government has achieved significant savings. In the SHILLELAGH program audited savings of $36.4 million were obtained. For the TOW, savings of $44.8 million have been verified. In the case of the most recent use of MICOM's method, on the DRAGON system, estimates of savings run as high as $90 million. Since the contracts have just been awarded for DRAGON, no audit has yet been accomplished. The savings shown are net figures. The cost of establishment of the second sources has been deducted.

In the case of all three of these systems the prime contractor carried the system through development and into initial production. As each system approached the point of full production, MICOM chose to qualify a second source and to compete the missile production in the case of SHILLELAGH and TOW and both the round and tracker in the case of DRAGON. These items were chosen because they were major components of the systems and would be produced in the largest quantities and thus offered the greatest potential savings to the Government.

This method of procurement requires as its initial step the development of a second source and has as its ultimate objective a buy-out in which the two sources compete in a "winner-take-all" multi-year competition.

The substantial quantities of these missiles which required production to extend over a long period of time insured that there would be sufficient time to qualify the second source and still have a very large quantity remaining to be bought in the "winner-take-all" competition. It was also estimated that there would be sufficient potential savings to pay for second source development.

The tools which were available but which had to be used together in the proper combination were (1) Leader Company Procurement, (2) Options, (3) Should Cost techniques, and (4) multi-year contracts. As we proceed, their use will become evident.

The Armed Services Procurement Regulation (ASPR), Section 4, Part 7 provides for Leader Company Procurement. Three optional procedures are made available. These models are illustrated in figure I. The first provides for a direct contractual relationship only between the Government and the Leader Company. The Government awards a prime contract to the Leader who is obligated to subcontract a portion of the

LEADER COMPANY PROCUREMENT PROCEDURES

models

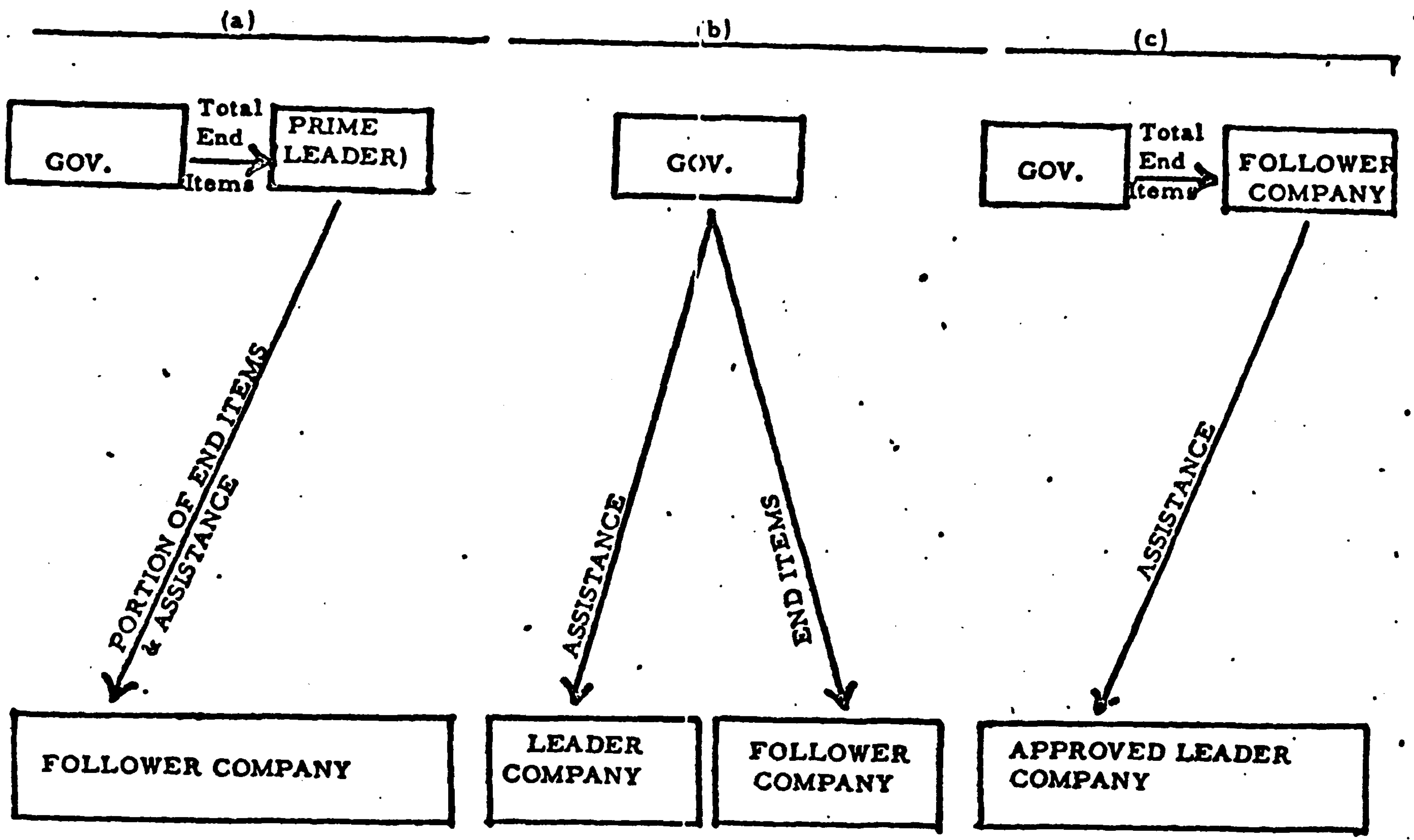


CHART-1-

Page el

end items to a follower company and to assist that company in production. In the second model the Government awards prime contracts to each of the Leader and Follower. The Leader Company contract calls for assistance to the follower. The Follower contract calls for production of end items. The third model calls for a contract for end items between the Government and the Follower which requires that there be a contract with the Leader for requisite assistance.

MICOM has chosen the second of these alternatives to use in its development of second sources. While there may be additional administrative expenses entailed in this approach, experience shows that it is preferable. It permits direct contractual access to both companies and thus allows the Government greater control of the situation. It allows the Government to exercise objectivity and precludes any possible conflicts of interest.

In addition to the actual development of a second source, a further critical feature is to provide an opportunity for the second source to reach a rate of production equal to that of the prime, so that he can compete on an equal footing. The options allowed for in ASPR enabled MICOM to accomplish this. The initial contracts with the second sources provided for only limited quantities as educational buys and which were used for tests to insure his becoming qualified. By including options which were exercised after qualification, the capability was provided to add on sufficient quantities to allow the second source to build up to a sustained rate of production.

The Government also provided in each case for a limited Competitive procurement between the two sources before the "winner-take-all" competition. This interim buy provides an opportunity to build up the production rate of both sources to insure that either will be able to meet Government requirements in the buy-out. For this split buy in which each is awarded a portion of the end items, Should Cost Techniques have proven valuable in assuring that the Government pays only a reasonable price.

The last important tool that of multi-year procurement has allowed for combining requirements for several years and thus encouraging true "pencil sharpening" in the final "winner-take-all" competition.

The previous overview provides the essentials of MICOM's concept. The following example taken from one of the actual experiences will provide more detail. In this example the procurement plan (see Figure 2) called for obtaining the first two years of production from the prime contractor. A production line had been established during the transition from development to production and thus production

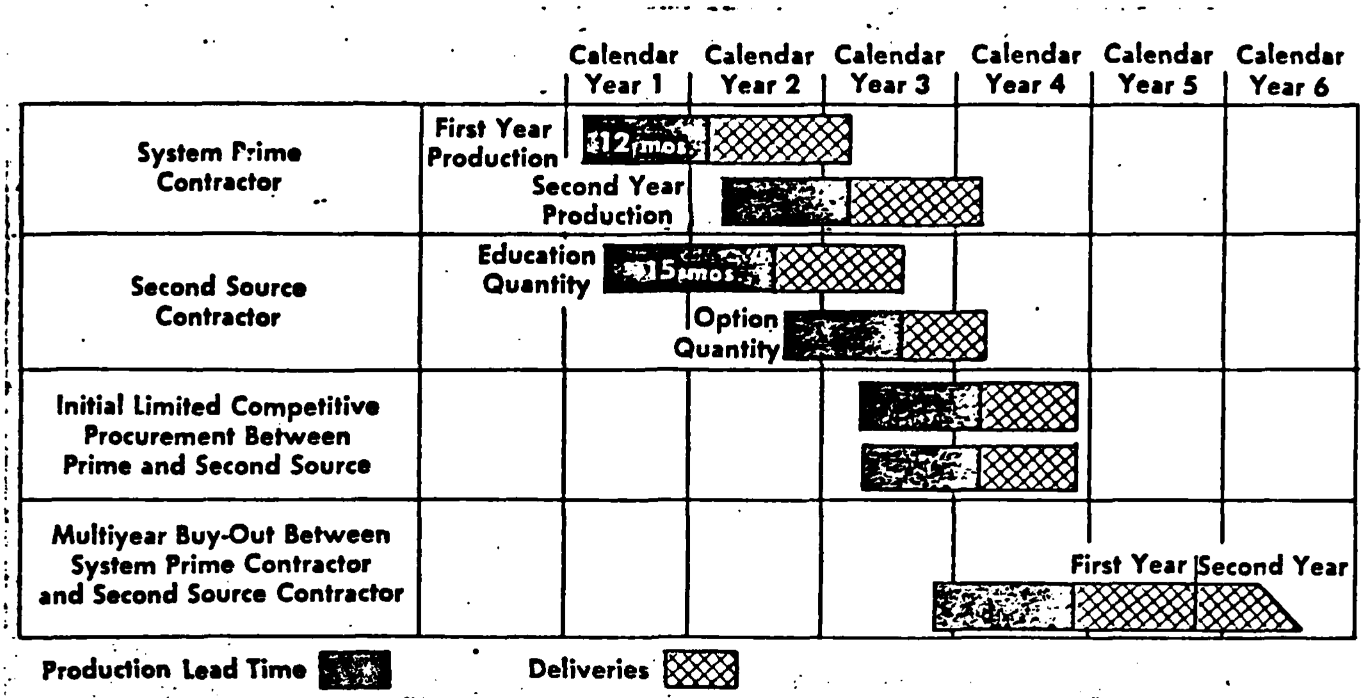


Figure 2. Missile production schedule.

large enough to make savings possible through price competition that would more than offset costs incurred by the Government in establishing the second source.

In addition to creating a qualified second source to introduce competition in what had traditionally been sole-source procurement, MICOM has achieved even larger savings by using "should cost" studies in competitive procurement.

This is how the procurement method was used in the most recent purchase. The Government, in order to meet its requirements, planned to get the first two years of missile production from the system prime contractor as sole source. A twelve-months' production leadtime with the prime contractor was used because a production line was already established as part of the transition from development to production (fig. 1).

Concurrently, the Government initiated a competitive procurement action among a large group of established missile system contractors to set up a second source missile producer under a firm fixed-price contract. Of necessity, the prime contractor was precluded from bidding. As indicated in figure 1, the second source producer was given fifteen months' production leadtime for a small initial quantity of missiles. This was an "education order" to prove that the second source could produce a quality item. As part of this contract, the Government had the option to order follow-on production quantities when the first items produced under the "education order" had been successfully tested and proved to meet contract requirements. In planning the final "buy-out," the Government thus insured that the second source producer got sufficient hardware orders to permit him to demonstrate his ability to achieve quantity production and bid competitively.

In addition, the Government procurement plan provided for an initial, limited competition between the two producers in which each would share a portion of the total missile production requirement for a specified period. This purchase occurs just before the final "buy-out" competition.

In soliciting proposals for the initial round of competition, the Government asked each producer to quote bids on five different quantities: 60, 55, 50, 45, and 40 percent of the total number of missiles to be procured. In setting up these percentages, care was taken to insure that the lowest percentage would equate a sufficient quantity to maintain a production rate capability for the multiyear buy-out for either producer. The request for proposal informed the producers that the Government intended to award contracts based on the lowest overall price obtained by combining quantities produced by both contractors.

In addition to meeting the Government's requirements for the third year, the initial competition gave the Government and the contractors the opportunity for a detailed cost analysis and review that could result in greater economies, particularly in the final buy-out competition.

MICOM decided to perform formal, indepth reviews, generally referred to as "should cost" studies, leadtime could be limited to twelve months.

Concurrently with the release of the first production procurement, a competition among a large number of established missile system producers was conducted to select a second source producer. The solicitation was on a firm-fixed-price basis. The successful competitor was given fifteen months production leadtime for a small quantity of missiles. As previously stated, this small quantity was used as an educational buy to insure that the second source could produce a quality product. An option to order follow-on production quantities was included in the contract which could be exercised once the items from the second source were tested successfully. The exercise of the option allowed the second source to demonstrate his capability to achieve quantity production and further assured that he would be able to be competitive in a future buy.

The required assistance to the second source from the prime was provided for through the medium of a concurrently running engineering service contract.

The initial competition between the two sources was limited in that neither contractor would receive the total quantity. In the solicitation for proposals, each was required to submit prices on five different ranges of quantities: 60, 55, 50, 45, and 40 percent of the total requirement for missiles. In addition, the solicitation reserved the right for the Government to issue a Letter Contract on a not to exceed basis if prices for the smaller quantities were considered excessive. In doing this it was necessary to insure that the lower quantities were of sufficient size to insure that if a competitor was awarded one of them he would still be able to maintain a quantity production. This precaution was necessary to insure a continued capability to compete in the planned buy-out. The request for proposal specified that contract awards would be made based on the lowest overall price to the Government.

This initial competition also gave the Government and both sources the opportunity to conduct a detailed cost analysis and review with an eye toward achieving the maximum economies.

MICOM decided to conduct in depth evaluations or should costs on both sources. While should cost was an established technique, it was the first time that the Army had utilized the technique in a competitive procurement.

This required that special attention had to be given to the conduct of these should costs to protect the integrity of the procurement process. Proprietary contractor data had to be protected from his competitor.

To accomplish the requisite protection, two individual and independent Should Cost teams were established. A separate team was assigned to each contractor. However, a joint chairman coordinated the efforts of both teams. This organization is reflected in Figure 3.

Whenever any interchange of information between the teams was required, it was transmitted through the chairman. The chairman had to guard against a competitive advantage accrual to either competitor as a result of information transmitted by Government personnel and had to insure the protection of all data which was validly restricted by the contractors.

Since both competitors had to utilize certain common subcontractors, it became evident that the competition would be meaningful only if these subcontractors provided the same data to the competitors. Therefore, a third group which was chaired by a member of the Should Cost chairman's staff performed a review of three major subcontractors who were supplying components to both the prime and the second source. The results of these reviews were provided to both competitors.

Great care was exercised to assure that there was no appearance that the Government had arrived at an acceptable price for these on both contractors. This marked the first time an Army agency had invoked "should cost" studies in a competitive procurement. For this reason, some of the details are worth examining.

Special attention had to be given to the conduct of the "should cost" studies to preserve the integrity of the Government procurement process. Detailed ground rules were established to insure that the Government and the contractors got maximum benefits from the analysis, yet preserved maximum competition. Care was also taken to protect proprietary information of the individual competitors.

Two independent "should cost" teams were set up by MICOM. The organization of the teams is shown in figure 2. A separate team was assigned to each contractor. An overall team chairman coordinated the efforts of both teams, and no contact was permitted between the teams. When an interchange of information was necessary, it was transmitted through the overall chairman. The chairman had to insure that no competitive advantage accrued to either contractor as a result of information transmitted by Government representatives and that all valid restrictions placed on the use of data by the contractors were observed.

Since both producers used certain common components obtained from the same subcontractors, it was evident that the studies would be valid only if the subcontractors provided identical data to both producers. To achieve this, a third group—headed by a member of the "should cost" chairman's staff—performed what amounted to a "mini-should cost" review in the plants of three major subcontractors supplying components to both the prime contractor and the second source. Both producers received the results of the subcontractor review.

The Government obviously assisted both the prime contractor and the second source by providing this information, but it took great care not to become involved to the degree that it appeared that the Government had arrived at an acceptable price for the components provided by the subcontractors. It remained for both producers to negotiate prices with their subcontractors. Each Government team, after completing a detailed in-plant review of the producer to which it was assigned, individually developed recommendations concerning various cost elements of each producer's proposal.

A departure from the normal sole source negotiations took place at this point. The Government held individual discussions with each producer and provided him with the team's detailed findings and conclusions as they pertained to his operations. Each producer was given two days to study the findings and identify areas of disagreement. At the conclusion of these discussions, the producers were given a final date to submit revised proposals for each of the five quantities if they desired to make revisions. The producers were instructed to furnish only a price with this submission. The Government reserved the right to obtain detailed costs to support the price, within five days

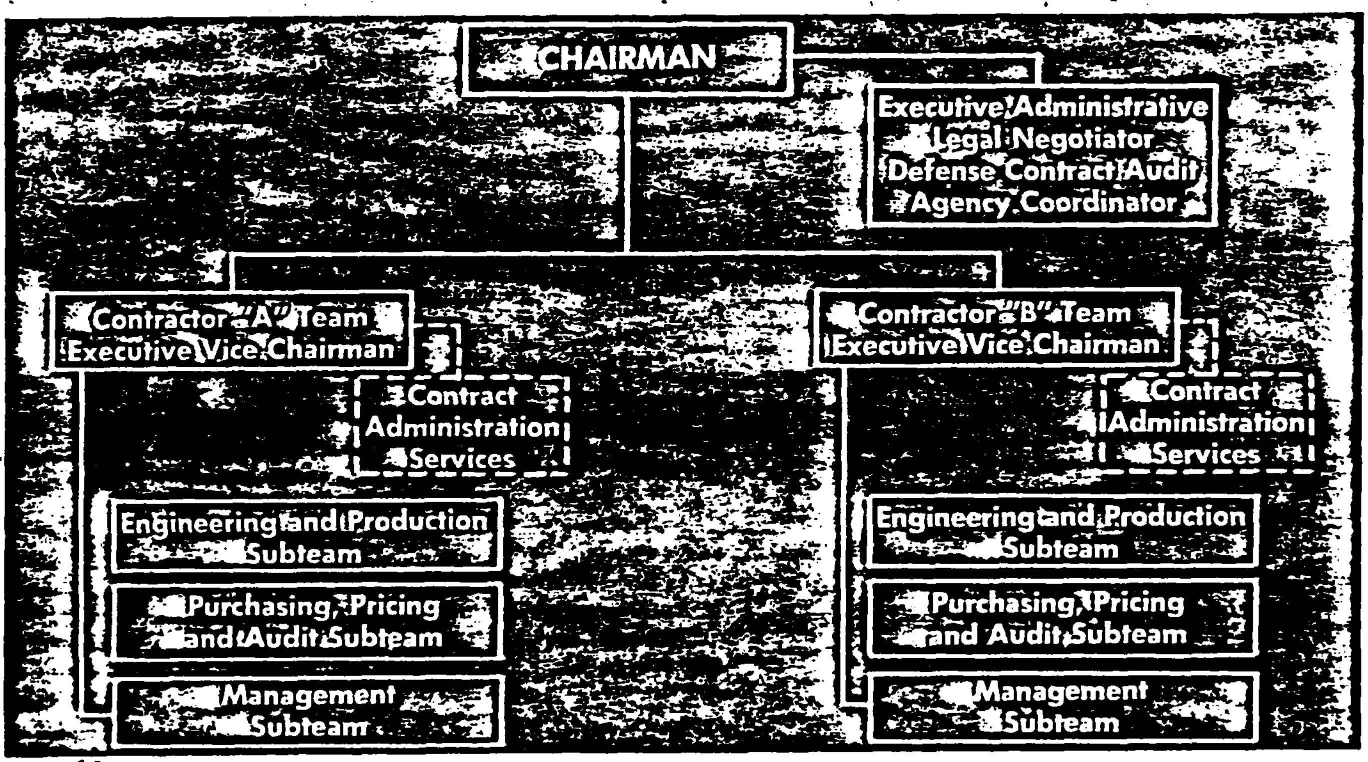


Figure 2. Organization of MICOM, "should cost" teams.

components. Both contractors negotiated their own prices with the subcontractors.

Each Should Cost team independently developed the recommendations concerning its assigned contractor's proposal. The Government held discussions with each offeror and provided him with the appropriate team's findings and conclusions with respect to his operations. The offerors were given time to review these findings and to identify areas of disagreement. At the conclusion of discussions the competitors were given a final date by which desired proposal revisions were to be submitted. They were instructed to furnish only a price but the Government reserved the right to request cost data if it so desired. The Government announced its intent to award on the basis of price competition, the higher quantity ranges of 55 or 60 percent if a contractor's price for either quantity, when added to the competing contractor's price for the corresponding lower quantity resulted in the lowest overall price to the Government. The alternative of awarding fifty percent to each producer remained available if more advantageous to the Government.

Figure 4 shows a grouping of the three alternatives. These are not the actual prices or quantities, but are representative.

	Quantity	Percent of Total Quantity	Column 1 Final Price Submissions		Column 2 Lowest Price Combinations of Alternate Quantities		Column 3 Low Price Alternate Awarded	
			Contractor A	Contractor B	Contractor A	Contractor B	Contractor A	Contractor B
Alternative A								
High Quantity	12,000	60	$72.0	$76.8	$72.0		$72.0	
Low Quantity	8,000	40	52.2	51.6		$51.6		$51.6
Total	20,000	100			$123.6		$123.6	
Alternative B								
High Quantity	11,000	55	69.3	70.8	69.3			
Low Quantity	9,000	45	58.5	58.2		58.2		
Total	20,000	100			$127.5			
Alternative C								
Quantity to Contractor "A"	10,000	50	63.9	64.5	63.9	64.5		
Quantity to Contractor "B"	10,000	50	63.9	64.5	63.9	64.5		
Total	20,000	100			$128.4		(Dollars in Millions)	

Figure 3. Comparison of proposed prices and lowest price alternatives.

after requesting it, if it so desired. The Government announced the intent to award on a price competition basis the higher quantity of 55 or 60 percent if the contractor's price for either quantity, when added to the competing contractor's price for the low quantity, resulted in the lowest overall cost to the Government. If this was not possible, the Government then had the option of awarding 50 percent to each contractor.

The prices that were submitted are grouped into three alternatives and are shown in figure 3. The figures shown are hypothetical and do not represent the actual prices or the quantities. Column 1 shows the total prices proposed for each quantity by each contractor. Column 2 shows the lowest price combination in each alternative, and column 3 identifies alternative A as the lowest overall price. The award, therefore, was made to contractor "A" for the high quantity and contractor "B" for the low quantity on a 60-40 split.

The Government achieved significant price reductions in this initial competition and split award. Both producers also were provided detailed information on areas where economies could be achieved and thus benefit them in pricing out their final "buy-out" proposals.

With missile production from both sources literally on target, some thirty-four months subsequent to selection of the second source, MICOM moved to the final phase of its long-range procurement plan—a multiyear contract for the total remaining Army requirement for the missile. MICOM set this major contract before both producers as the prize in a "winner take all" price competition. The solicitation for this requirement included multiyear firm quantities, options for each year, and an add-on option quantity at the end for twelve additional months' requirements. The option quantities were to satisfy anticipated additional requirements in the same time frame that were not yet firm.

Upon receipt of the producers' proposals, MICOM again found that major price savings had been achieved and made the final contract award.

Four major factors contributed to the more than $40 million savings realized in the series of contracts with the two producers that comprised the total missile production program.

First, it was determined that a requirement existed for a large quantity of missiles to be produced and delivered over a number of years. Second, it was decided that a second source missile producer must be selected by competition once his qualifications to produce missiles were established. Third, it was determined that a first-of-its-kind "should cost" review be made of the two competing contractors. And fourth, it was realized that old fashioned price competition had to exist between the two fully qualified producers. ALOG

Mr. J. A. Muller is chief of the Procurement Division, U.S. Army Missile Command, Redstone Arsenal, Alabama. A recognized expert in missile procurement, he has been employed at the Arsenal since rocket and missile activities were consolidated there in 1951.

Column l reflects the final proposals for each alternative. Column 2 shows the lowest combination of prices for each alternative. Column 3 shows that the lowest overall price to the Government resulted from alternative A. The award was therefore made on the basis of 60 percent to Contractor A and 40 percent to Contractor B.

The Government achieved an 8.7 percent unit price reduction in this initial limited competition. Further, both producers were provided with detailed information on areas where economies could be achieved and thus benefit them in their proposal in the "winner-take-all" competition.

Some thirty-four months subsequent to selection of the second source, MICOM moved into the final phase of its long range procurement plan - a multi-year contract for the total remaining Army requirements for the missile. This phase was conducted as a "winner-take-all" price competition. The solicitation was structured to include the multi-year firm quantities, options for additional quantities within each year, and an add-on quantity at the end for an additional twelve months requirements. The options were to satisfy anticipated but not firm requirements during the same time-frame.

The proposals again reflected major price savings and final contract award was made to the lowest cost producer. During this full competition the unit price reduction was 35.9 percent.

There are some significant considerations in electing to utilize this approach. First, the quantities required should be sufficient to insure that there are potential savings enough to pay for development of the second source. These quantities should extend over a sufficient period of time to allow for second source qualification. Secondly, there must realistically be a potential second source available. Third, the utilization of Should Cost techniques can contribute significantly to the process. Fourth, the second source must be developed to produce at rate which will allow for old-fashioned price competition between the producers.

ABSTRACT

The paper is titled Fostering Economic Competition Through Federal Procurement. The authors are Keith Malley and Don Templeman and both can be reached at:

Small Business Administration
Technology Assistance Division
1441 L Street, N.W.
Washington, D.C. 20416

(Telephone: 202-653-6586)

The paper consists of 30 single spaced typewritten pages and includes 15 separate pages of tables and figures in addition to a section containing footnotes and a bibliography. Presentation time is under 30 minutes. Videographs of selected tables and figures included in the paper would serve as helpful presentation aids. The paper addresses the theme of competition and is intended for use in a working group. It is suggested that Don Templeman present the paper.

The paper presents an overview of the impact that Federal procurement may exert on the competitive structure and performance of the American economy. It opens with a brief description and review of the significance of perfect and workable competition as defined by economists. It then summarizes the disagreement among economists concerning the proper means of measuring the amount of competition that exists in the actual economy. In this regard, a general overview of the level and trend of economic concentration in the important manufacturing industry is presented and the effects that such concentration may exert on the competitive operation of the economy as a whole are indicated.

The next major part of the paper discusses the relationship between procurement by the Federal Government and economic concentration and competition in the manufacturing industry.

It is stated that if Federal procurement is not promoting reduced concentration and increased competition in this sector of the economy, then it must be promoting the reverse. Consequently, it is suggested that procurement offices take note of this fact and conduct research to develop a system of procurement designed to promote economic competition. Specific areas for such research are suggested, namely:

(1) Research to determine how to place a greater and more effective emphasis on procurements from small business,

(2) Research to develop procurement criteria designed to promote competition among medium-sized and larger corporations, and

(3) Research to develop a procurement numerical scoring system which incorporates a criteria to take account of "the potential impact on competition" that a particular procurement may generate.

FOSTERING ECONOMIC COMPETITION

THROUGH FEDERAL PROCUREMENT

A Paper for the 5th Annual
Department of Defense
Procurement Research Conference

By: Keith Malley and
Don Templeman

August 24, 1976

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

Introduction

America has professed a belief in the merit of free economic competition since the day of Adam Smith. Despite this the Nation today is characterized by a mixed economy with extensive private oligopoly and Government-regulated monopoly in addition to competition. The resulting dichotomy between the Nation's economic aspiration and the Nation's economic reality will be the subject of the first part of this paper. The second part of the paper will study the relationship between this dichotomy and Government procurement. Finally, questions will be raised which may allow Government procurement to contribute to a reduction in the gap between economic aspiration and reality.

CHAPTER II

Theory of Competition

Perfect Competition Defined

Perfect competition, as defined by economists, has rarely existed. Nevertheless, the theory is widely utilized, and is useful to the extent that it provides a description of how an optimum economy might operate. Perfect competition is characterized by the following important assumptions:

(1) The number of buyers and sellers is so large in relation to the market involved that no one buyer or seller alone can affect the price of the product.

(2) The product is homogeneous.

(3) All resources are fully mobile, and freedom of entry into the market exists.

(4) Buyers and sellers possess perfect knowledge of the terms of sale and have the opportunity to revert to such terms.

(5) All other things are equal (i.e., population, social trends, etc.).

Given these assumptions, it is impossible to classify any American industry as perfectly competitive. Some agricultural markets approach perfect competition but many of these markets are heavily affected by Government programs.

Significance of Perfect Competition

Economists are interested in perfect competition largely because of the theoretically optimum economic conditions it would produce. Under perfect competition, price settles at a demand/supply equilibrium. The market thus clears at all times and the development of excess capacity is discouraged. Production is set where management cost equals price, and thus expands only if demand expands or if marginal cost drops. Either occurrence results in price being greater than marginal cost, leading to an expansion in marginal revenue and resulting in an influx of firms into the industry, with marginal cost rises and once again equals price. An optimat use of resources thus occurs, as productive factors shift in response to demand, as revealed by the flexible price system. Meanwhile, technical innovations are developed and utilized quickly, as firms try to cut marginal costs. Furthermore, distribution of output is dependent on income, which in turn depends on the contribution to production rendered by the input involved; and the price, and so demand, for the output produced by that input. Maximum economic growth is thus induced. Adam Smith's "invisible hand" comes into play, for although all compete against each other, the assumptions of perfect competition result in a maximation of total welfare.

Workable Competition

If the assumptions which underlie perfect competition rarely occur, how is it that the American economy can be said to be based on competition? John Clark addressed this question in 1940 when he developed the concept of "workable competition."[1] (sometimes referred to as effective competition). Workable competition is an elastic concept which embraces behavior and performance as well as structure. The following conditions are used by economist to determine if competition in a particular industry is workable:

(1) The number of effective competitive sellers (and buyers) is large enough.

(2) Opportunity for entry into the industry is easy enough.

(3). Independence of rivals exists.

(4). The rate of growth of the industry is sufficient.

(5). Product differentiation in the market is mild enough to promote substitution.

(6). Price flexibility and freedom to undercut the prices of rivals exists in sufficient degree.

(7). Predatory pricing is absent or insignificant.

(8). Excess capacity is not too large.

Different subjective judgements by different economists will result in different weights being attached to the above conditions when determining whether workable competition does or does not exist in a particular industry. Thus the concept is nebulous and variable, and so has been used for policy purposes, for an industry with workable competition can expect to escape antitrus action. It is workable competition that economists refer to when they speak of the competitiveness of the American economy. Economists generally agree that such competition provides the most effective means of achieving greater efficiency, more innovation, full employment, and economic growth.

CHAPTER III

Competition in the American Economy

Disagreement Among Economists

It is precisely because of the subjective judgments involved in ascertaining the existence of workable competition that economists have found it impossible to specify the amount of competition in the American economy. A certain broad consensus on how to approach the issue does exist, however, and this consensus is articulated in an antitrust case involving the Philadelphia National Bank where the Supreme Court held that:

> ...a merger which produces a firm controlling and undue percentage of the relevant market, and results in a significant increase in the concentration of firms in that market, is so inherently likely to lessen competition substantially... /that it provides a test which is/ fully consonant with economic theory. That "competition is likely to be greatest when there are many sellers, none of which has any significant market share" is common ground among most economists... 2/

It is on this common ground that the Antitrust Division of the Department of Justice stands. The division looks at all of the conditions pertaining to workable competition when assessing the state of competition in an industry, but the factor that is considered most important in most assessments is the concentration ratio describing the share of the market held by the largest four firms in that industry. Such ratios are produced by the Bureau of the Census using the Standard Industrial Code (SIC) which consists of 20 major industry groups with 450 manufacturing industries and 1014 product classes. The data derived from the Code has many limitations, for between 1947 and 1966 237 of the four-digit industries changed in classification, but it is the best data available. Thus, the Antitrust Division and most economists, particularly those involved in research on the question of competition and market power which may impede competition, rely increasingly on the concentration data as a proxy describing oligopolistic market power. According to this approach, an industry is highly concentrated when the four-firm concentration ratio is over 50%, moderately concentrated when the ratio is between 25% and 50%, and unconcentrated when the ratio is below 25%. A highly concentrated industry can be classified as an oligopoly, for the large firms in it possess market power which allows them to influence the price of the product by their output decision. Furthermore, the development of collusion among the large firms becomes more likely, and even in the absence of such collusion, effects similar to what it would produce can arise. Thus, the large firms may earn persistently high profits, over time, and price competition may be insignificant.

Some economists will argue against this approach, however. John McGee's In Defense of Industrial Concentration, for example, states that "there is no clear relationship between concentration and competitiveness."3/ McGee feels that oligopolies may be competitive and often are efficient. But in contrast to this viewpoint is that articulated by Judge Learned Hand in the 1945 antitrust case against Alcoa:

> We have been speaking only of the economic reasons which forbid monopoly, as we have already implied there are others, based upon the belief that great industrial consolidations are inherently undesirable, regardless of their economic results.4/

Hand indicates that concentration and oligopoly lead to political and social power which may exert pervasive effects on the rest of society. Such effects can be particularly perverse given the Nation's continuing faith in the ideology of free competitive enterprise.

Concentration in the American Economy

Although there are approximately 1,700,000 corporations and 9 million small businesses in the American economy today, aggregate economic concentration is significant. This is because of concentration in the industrial manufacturing sector, which constitutes the core of the economy and according to President Nixon's Cabinet Committee on Price Stability Study is highly critical in achieving high employment, economic growth, and price stability.5/ Noting that at least ten of the giant oil firms (which because of tax advantages allocate much of their operation to mining) are not included in the SIC data on this sector, aggregate concentration in the American manufacturing industry can be demonstrated:

TABLE 1 6/

COMPARATIVE SHARE OF VALUE ADDED IN MANUFACTURE ACCOUNTED FOR BY LARGEST MANUFACTURING COMPANIES

	% of Value Added in Manufacturing			
	1947	1958	1966	1972
Largest 50	17	23	25	25
Largest 100	23	30	33	33
Largest 150	27	35	38	39
Largest 200	30	38	42	43

Source: U.S. Bureau of the Census, Concentration Ratios in Manufacturing Industry, 1972.

The table shows a steady increase since World War II in the share of the largest manufacturing corporations in the value added by all manufacturing corporations. Value added is the economic measurement for the difference between a firm's input and output, and represents the economic "activity" the firm performed.

Tables 2 and 3 further illustrate aggregate concentration:

TABLE 2 7/

PERCENTAGE OF TOTAL MANUFACTURING ASSETS HELD BY 200 LARGEST MANUFACTURING CORPORATIONS (RANKED BY ASSETS HELD)

1929	45.8	1931	49.0	1933	49.5	1935	47.7	1937	49.1	1939	48.7
1941	45.1	1947	45.0	1948	46.3	1949	47.1	1950	46.1	1951	46.1
1952	47.7	1953	48.7	1954	50.4	1955	51.6	1956	52.8	1957	54.3
1958	55.2	1959	54.8	1960	55.2	1961	55.4	1962	55.1	1963	55.5
1964	55.8	1965	55.9	1966	56.1	1967	58.7	1968	60.4		

SOURCE: Federal Trade Commission Staff, Economic Report on Corporate Mergers

TABLE 3: 8/

COMPARATIVE SHARE OF ALL MANUFACTURING SALES, ASSETS, NET INCOME, AND EMPLOYMENT ACCOUNTED FOR BY TOP 200 FIRMS (RANKED BY SALES)

	1955	1965	1974
Sales	47.7	50.5	62.5
Assets	53.0	57.0	66.8
Net Income	63.6	60.4	62.1
Employment	39.5	48.4	60.7

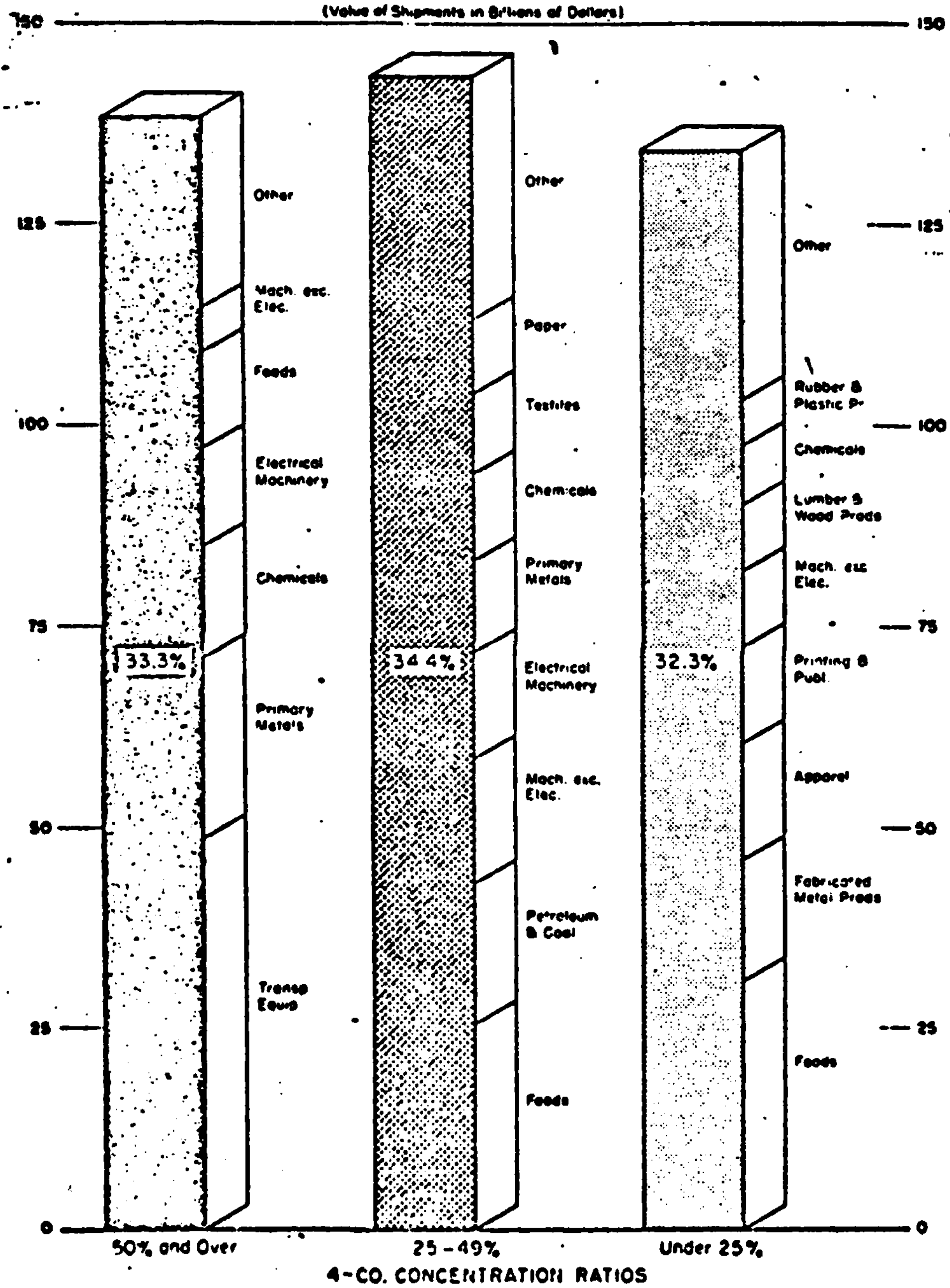
SOURCE: FORTUNE MAGAZINE - "Future Directory of the 500 Largest Manufacturing Corporations"; FTC - Quarterly Financial Reports of Manufacturing Corporations; Department of Labor, Bureau of Labor Statistics - Monthly Labor Review.

Again, note the increase in the share of the various variables accounted for by the largest corporations. The extent and trend of aggregate concentration in the economy is thus apparent. Estimates regarding the contribution of corporate mergers to this trend during the years 1947-68 range from 84% to 41%. The rate and size of merger activity has subsided considerably from the active 1967-69 period.

Figures 1 and 2 on the next two pages continue the analysis of economic concentration by focusing on market concentration. Figure 1 reveals that in 1963 one-third of the total value ($415.7 billion) of manufacturing shipments were made by concentrated industries. Figure 2 demonstrates what percentage of shipments of each of the 20 major industrial groups were made by concentrated industries within that group.

FIGURE 1

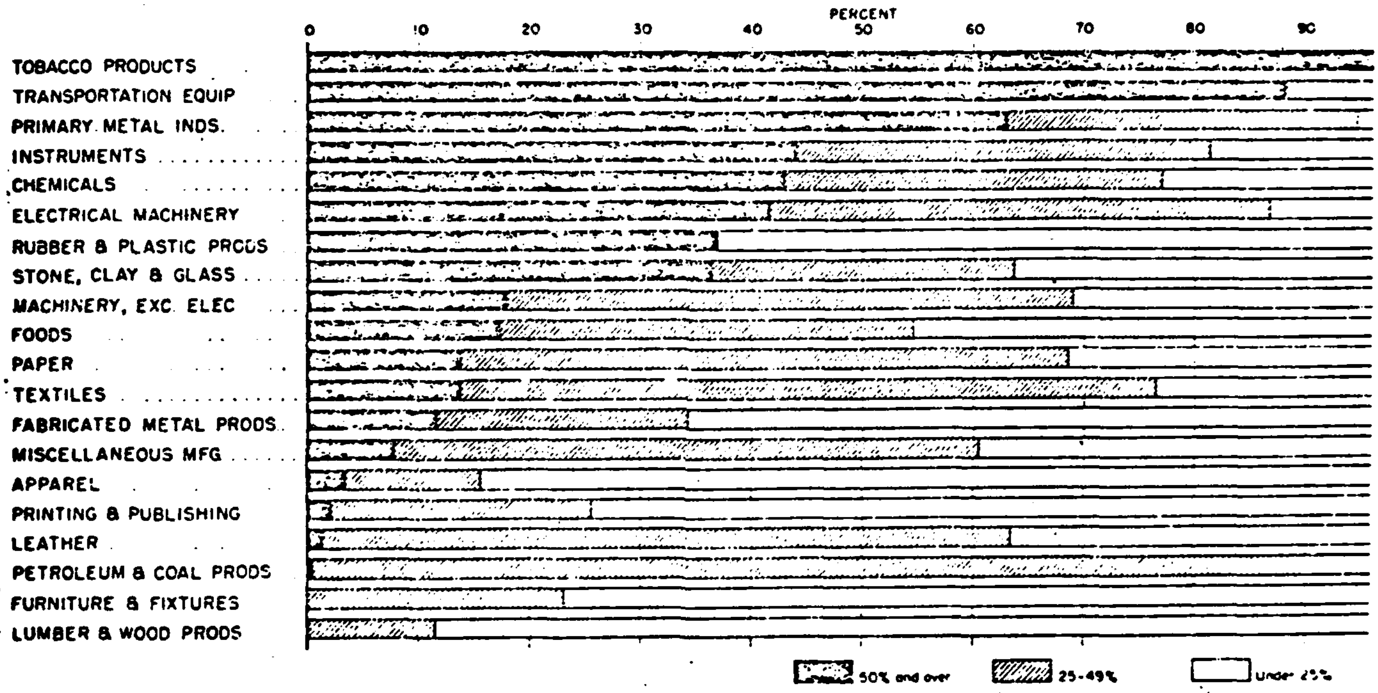
TOTAL MANUFACTURING
DISTRIBUTION OF TOTAL VALUE OF SHIPMENTS
BY CONCENTRATION RATIOS, 1963



Source: Bureau of the Census, Department of Commerce, 1963 Census of Manufactures, 1966, Vol I, Table 2

FIGURE 2

DISTRIBUTION OF VALUE OF SHIPMENTS
BY CONCENTRATION RATIOS OF COMPONENT INDUSTRIES, 1963



Source: Computed from Bureau of the Census, Department of Commerce, 1963 Census of Manufactures, 1966

The actual degree of concentration may actually be understated by this Census data, however. To reflect genuine market concentration it is necessary to take account of spatial submarkets, divisions among non-competing products, and import competition. William Shepherd did this in his book Market Power and Economic Welfare and reached the following results:

TABLE 4 11/

PERCENTAGE SHARES OF TOTAL U.S. MANUFACTURING VALUE-ADDED IN 1966 THAT OCCURRED IN INDUSTRIES OF VARIOUS DEGREES OF CONCENTRATION

Shares of Value-added, according to

Degrees of concentration in the largest four firms	Raw Census Concentration Ratios 1958	Raw Census Concentration Ratios 1966	Adjusted Concentration Ratios 1966
90-100	2.1	1.6	17.0
80-89	2.0	2.4	9.0
70-79	9.4	11.5	8.0
60-69	4.1	5.8	15.1
50-59	13.1	7.5	14.7
40-49	7.3	13.6	14.7
30-39	13.0	10.8	9.7
20-29	22.5	27.2	9.1
10-19	19.0	13.7	2.3
0-9	7.5	5.9	0.4
70 and higher	13.5	15.5	34.0
40 and higher	38.0	42.4	78.5
"Average" degree of concentration	37.2	39.0	60.3

SOURCE: Calculated from data in U.S. Senate Subcommittee on Antitrust and Monopoly, Concentration Ratios in Manufacturing Industry, 1963, Parts 1 and 11, (Washington, D.C.: U.S. Government Printing Office 1966); and U.S. Bureau of the Census,"Value of Shipment Concentration Ratios by Industry" Annual Survey of Manufacturers, 1966. M66 (AS)-8 (Washington, D.C.: U.S. Government Printing Office, 1968).

Notice particularly the lack of industries where the largest four firms accounted for less than 20% of the market. Such industries produced less than 3% of the value added by all manufacturers. If the adjustments made by Shepherd are accurate, then, concentration in the American manufacturing industry is substantially greater than Census ratios indicate.

Concentrated Competition?

Given the degree of concentration and market power that exists in the vital manufacturing sector of the American economy, it is necessary to determine the resulting effects on general economic competition and performance. A number of economists have addressed this topic, and this section will present a brief overview of their conclusions.

Concentration and Profits: The effect of concentration on profits has received the greatest attention from economists. If profits rise with concentration, the existence of non-competitive oligopoly can be inferred, for an oligopoly would not produce at the point where price equals marginal cost with a resulting competitive profit, but would instead produce below the point where price equals marginal cost, and would so gain a larger monopolistic profit. Most studies have found such a correlation of profits with concentration, but some economists dispute the significance of the correlation.

Figure 3 on the next page shows the results of the early studies conducted on profits and concentration. All exhibit the postulated oligopolistic relationship. The relationship becomes far more defined if the adjusted concentration data developed by Shepherd is utilized.

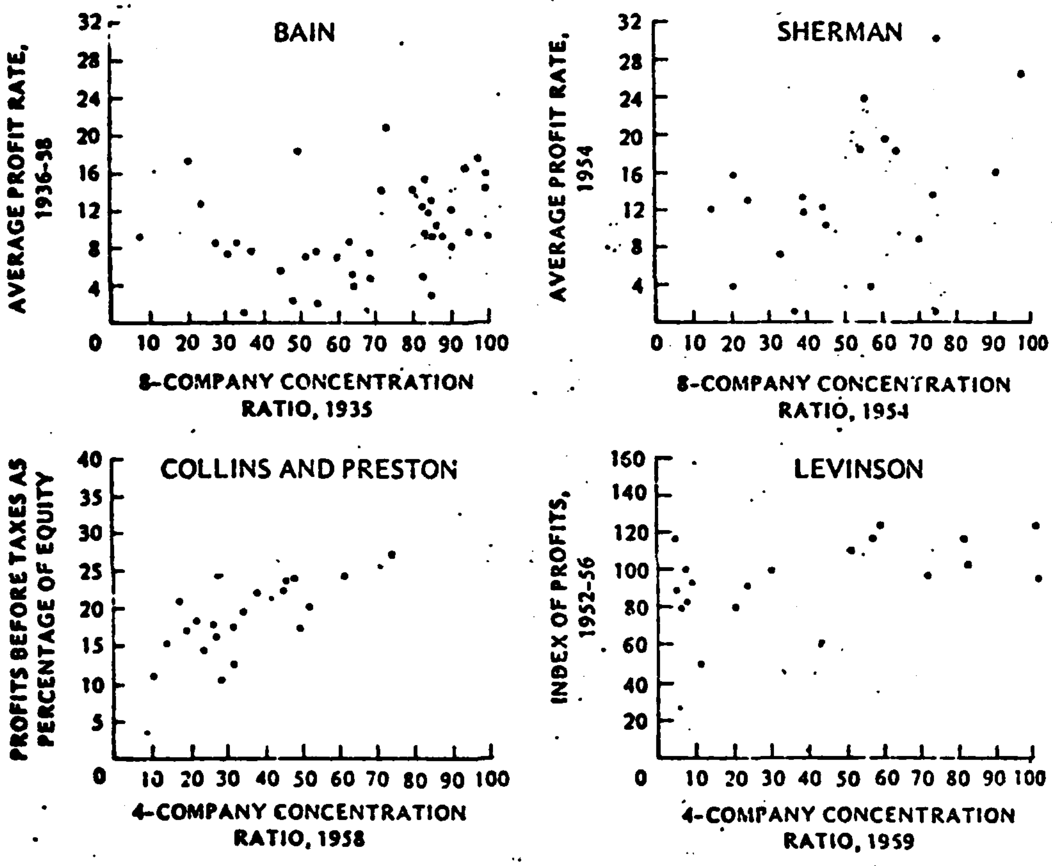
Some economists have attacked the conclusions that the following studies lead to. Brozen has contended that although concentrated industries may enjoy high profits for a time, over the long run their profits tend to move to average levels. 14/ Other economists have contended that the relation between profits and concentration is due to efficiency and technology and not actual oligopolistic collusion. This viewpoint seems to neglect the fact that if the profits of the concentrated industries are due to such factors, the resulting benefits are being retained by the industries as profits and are not distributed to society at large in the form of lower prices.

Concentration and Prices: The effect of concentration on prices has also been the subject of intense study by economists. Most of these studies have centered around the administered price thesis developed by Gardiner Means in the 1930's. This thesis is surrounded by much

FIGURE 3

RELATIONSHIP OF CONCENTRATION TO PROFIT RATES

Four studies

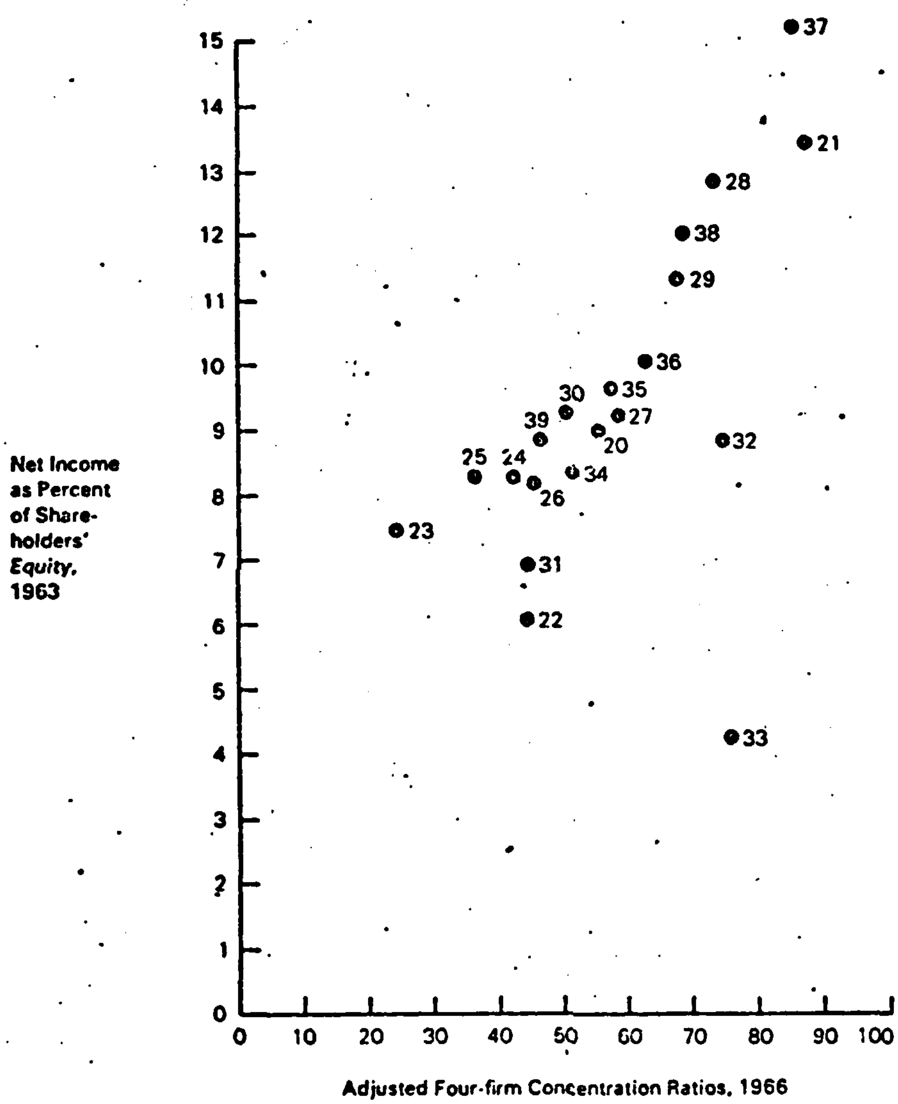


Source: Norman R. Collins and Lee E. Preston, *Concentration and Price-Cost Margins in Manufacturing Industries*, University of California Press, 1968, Figures 1, 3, 6, 8

FIGURE 4

Adjusted Concentration and Profit Rates Across Broad Industry Groupings, 1963.

(Percentage)



NOTE: The number by each observation is the Census Standard Industrial Classification code number for the industry group

SOURCES: Net income as a percent of shareholders' equity from Federal Trade Commission, *Rates of Return in Identical Firms in Selected Manufacturing Industries, 1940, 1947–65* (Washington, D.C.: U.S. Government Printing Office, 1967); adjusted concentration ratios from Table 7.2., *supra.*

controversy, partly because Means refined the concept in the 1950's. It was first advanced as an explanation for perverse price rigidity during the depression when concentrated industries held prices near pre-depression levels. Under a competitively structural economy, this could not occur,for if demand fell, prices would also fall until they reached a level where demand was sufficient to clear the market. Movement out of the depression would then begin. The administered price thesis explained the failure of the economy to act this way by arguing that concentrated industries "administered" or set prices independently of competitive market forces. Such industries tended to cut production and employment rather than prices. Means used Figure 5 on the following page to illustrate his point. Note the inverse relationship between changes in price and concentration ratios.

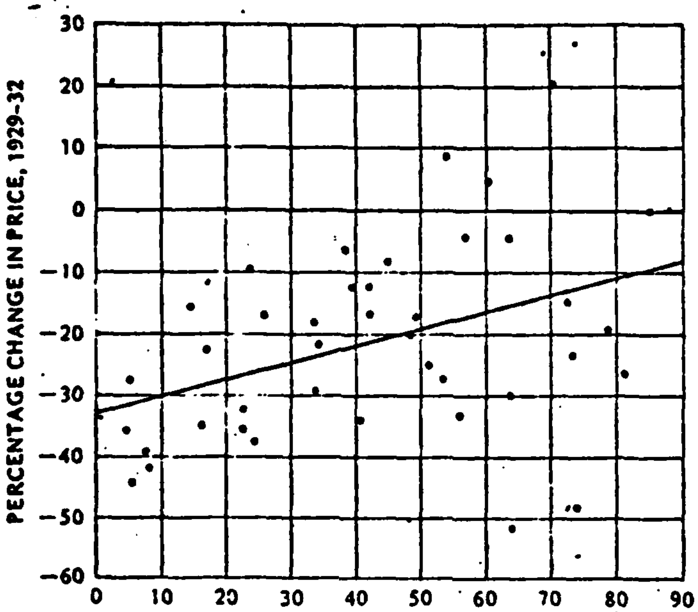
Some economists contended that Means used inappropriate price and market data in this analysis. Thorpe, in a study for the Temporary National Economic Committee in 1941, concluded that the differences in depression price flexibility were the result of different product characteristics.

In the 1950's, Means refined the administered price thesis into an explanation for creeping inflation, holding that over the long run administered prices either rose or held steady, while other prices both rose and fell. Creeping inflation is in this case a result of the downward movement of some flexible prices being insufficient to do more than temporarily slow down the continuous rise in prices brought about by administered pricing. Again, controversy arose over the Means' position, and certainly much of it was warranted for inflation is caused by many factors (i.e., growth in the money supply, increase in costs, excess aggregate demand, etc.) besides administered prices. Nevertheless, as Kahon says, "enough of /the evidence concerning price behavior in the 50's/ is now in to demonstrate that Means was right." 16/

Despite this controversy continues to the present. For example, in an analysis of the recession of 1969-70, Blair produced Table 5, describing the relationship between Concentration Ratios and Percentage Price Changes.

FIGURE 5

RELATIONSHIP BETWEEN CONCENTRATION AND DEPRESSION DROP IN PRICES



Source: National Resources Committee, *The Structure of the American Economy*, 1939, Pt. 1, Chart 2, prepared under the direction of Gardiner C. Means

TABLE 5

CONCENTRATION RATIO AND PERCENTAGE PRICE CHANGE OF 347 PRODUCT CLASSES

December, 1969, to December, 1970

	Total	Increases		Changes of Less than + 2.0% or −2.0%	Decreases	
		5.0% and Over	2.0% to 4.9%		−2.0% to −4.9%	−5.0% and Over
All product classes						
50% and over	134	53	38	34	5	4
25% to 49%	140	55	40	23	8	14
Under 25%	73	24	20	8	7	14
Total	347	132	98	65	20	32

Source: Prices: Bureau of Labor Statistics, Department of Labor, Wholesale Price Index; Concentration ratios: *Concentration Ratios in Manufacturing Industry, 1963*, 1966, Pt. 1, Table 4

The table indicates that a concentrated industry is much more likely to increase price than is an unconcentrated industry. In contrast to this are recent statistical analysis by Lustgarten, Weston, and Crottke which deny any such relationship for the 1969-70 recession.

If there is no consensus among economists regarding the administered price thesis, there is still general agreement that in most circumstances concentration increases the possibility of prices being rigid with little downward flexibility.

The Shepherd estimates that oligopolistic market power leads to prices 10-30% higher than would otherwise exist.18/ The Nader Study, likewise, cites an internal FTC memorandum which states that prices could decline by 25% if all four-firm concentration ratios were reduced to 40% or less. 19/

Concentration and Technological Innovation: Schumpoter and Galbraith have argued that concentration can promote technological progress. According to this view, the giant firm can allocate much greater organized research and development support for technological innovation leading to such progress. Most studies do not confirm this proposition, however. For example, an analysis by Scheirer cited the following data:

TABLE 6 20/

INNOVATIONS PER 10 THOUSAND R&D SCIENTISTS AND ENGINEERS

	firms with less than 1000 employees	firms with 1000 or more employees
1953-59	8.2	2.6
1960-66	12.0	1.8
1967-73	13.1	1.7

SOURCE: National Science Foundation

The innovations selected for inclusion in this table were those deemed most significant by a panel of experts. The data indicates that a small firm has a much greater rate of significant innovation per numbers of people engaged in research and development than does a large firm. Such small firms do not hold a significant share of any market.

Other studies notably by Jewekes, Mansfield, and Scherer, have focused not on the rate of innovation per firm size, but rather on the rate of innovation per concentration in the relevant industry. No association between concentration and technological change has been discovered.

The record of innovation in the steel industry can be cited here. None of the thirteen major innovations in steel production between 1940 and 1955 were introduced by American corporations. The important oxygen steelmaking process, for example, was introduced by a tiny Austrian firm. The first American corporation to adopt the process was McLouth Steel, with a 1% share of the industry capacity. U.S. Steel and Bethlehem Steel, the American giants, did not utilize the process until 1964, 10 years after its adoption by McLouth. As a result, the American steel industry continues to face strong inport competition.

Concentration and Efficiency: A common argument is that concentration arises and persists because of the efficiency brought about by economies of scale. According to this argument, large firms, particularly in certain industries, gain effeciencies which are not available to small. The most extensive study on this issue was conducted by Bain. In Barriers to New Competition, he found that efficiencies increase and unit costs decrease up to a point, beyond which efficiencies decrease and unit costs increase. At the twenty industries he studied, 19 were characterized by a concentration ratio greater than that required by single plant economies, and in over half the uses the ratio was very substantially greater. The Cabinet Committee on Price Stability agreed with this assessment, and said that "existing concentration levels in many industries are greater than necessary to achieve economies of scale." 21/Other studies have reached similar conclusions. Furthermore, in those industries where economies of scale do cause extreme concentration, appropriate Government regulation is necessary, for it is generally understood that a lack of regulation in such circumstances will result in monopolistic behavior.

When concentrated industries characterized by little technological innovation achieve high profits by raising prices or by retaining the benefits of economies of scale without reducing prices, the result is a perverse price sustem which misallocates resources, contributes to unused capacity and unemployment, and reduces final output and growth. The lossof GMP which thus occurs has been estimated at 6.2% by Scherer. 22/ Kamerschen has agreed, estimating the loss as 6% of National income. 23/ These ratios translate into approximately $90 billion.

CHAPTER IV

IMPLICATIONS FOR PROCUREMENT

Procurement and the Economy

America's Federal Government is the largest procurer of goods and services in the world, and in Fiscal 1975 contracted to spend an estimated $64.9 billion. 24/ Procurement of this magnitude inevitably affects the economic structure of the Nation. However, little attention has been given to this fact.

> On the one hand, the function of the Antitrust Division is to preserve and strengthen competition, while loans and other forms of assistance are provided to smaller firms by the Small Business Administration. On the other hand, government is a powerful contributer to high concentration and the suppression of competition. It contributes directly to concentration by the manner in which it procures what it needs, disposes of what it no longer needs, and leases to others what it owns. 25/

The largest federal procurers are the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Energy Research and Development Administration (ERDA). Table 7 shows their procurements for Fiscal 1975. Note that the total procurement of the three accounted for over 5% of the value of industrial shipments in that year.

Table 7 PROCUREMENT BY DEFENSE, NASA AND ERDA

Agency	FY 1975 ($ billions)
DOD	$45.8
NASA	2.6
ERDA	4.0
Total	$52.4
As % of value of industrial shipments	(5.3)

Note: Figure in parenthesis is estimated
Source: Internal SBA Data

Table 8, on the following page, shows the significance of federal prime contracts for procurement for a selection of 48 of the largest research and development-orientated firms in 1966-67. No clear relationship is

TABLE 8
Federal Purchases and R&D Support in a Large Selection of R&D Oriented Firms, 1966-67

Sales Rank Among all Industrial Firms, 1966	Company	Company Sales 1966	Federal Prime Contracts for Purchases, 1966–1967	Federal R & D Related Contracts 1966–1967	Federal Prime Contracts for Purchases	Federal R & D Related Contracts
			($ million)		As Percentage of Firm Sales 1966	
1	General Motors	20,209	762	137	3.8	0.7
2	Ford	12,240	540	136	4.4	1.1
4	General Electric	7,177	2,019	729	28.2	10.2
5	Chrysler	5,650	144	79	2.5	1.4
9	IBM	4,248	410	215	9.7	5.1
11	Western Electric	3,624	117	623	30.8	17.2
12	DuPont	3,185	287	107	9.0	3.4
19	Westinghouse	2,581	651	198	24.3	7.4
20	RCA	2,549	379	111	14.9	4.4
21	Goodyear Tire & Rubber	2,476	221	66	8.9	2.7
22	GT&E	2,391	319	180	13.4	7.5
23	Boeing	2,357	1,406	494	59.7	21.0
27	Union Carbide	2,224	334	287	15.0	12.9
28	IT&T	2,121	282	27	13.3	1.3
29	Lockheed	2,085	2,558	751	122.8	36.0
30	North American Aviation	2,024	1,938	1,249	95.7	61.6
32	General Dynamics	1,797	2,368	536	132.0	29.8
34	Eastman Kodak	1,742	111	2	6.4	0.1
36	United Aircraft	1,663	1,213	116	73.0	7.0
37	Monsanto	1,612	34	34	2.1	2.1
49	Uniroyal	1,321	218	1	16.5	0.1
50	Dow Chemical	1,310	111	44	8.5	3.4
54	Allied Chemical	1,246	—	—	0	0
57	Litton	1,172	194	14	16.5	1.2
61	Textron	1,132	531	36	47.0	3.2
62	Olin Mathieson	1,117	155	1	13.9	0.1
66, 73	McDonnell-Douglas	2,109	2,593	481	123.4	22.9
67	Grumman	1,059	1,043	555	98.5	52.4
69	Bendix	1,052	539	243	51.2	23.1
80	General Tire & Rubber	1,002	448	175	44.8	17.5
87	Honeywell	914	370	56	40.4	6.1
93	TRW	864	264	143	30.6	16.6
113	Raytheon	709	403	98	56.9	13.8
120	Martin-Marietta	670	471	181	70.2	27.0
125	Zenith	625	1	1	0.4	0.4
130	Ogden	612	237	—	38.7	0
131	Hercules	610	201	6	33.0	1.0
132	Kaiser Industries	609	308	2	50.6	0.3
134	Avco	604	564	115	93.4	19.1
138	Texas Instruments	580	128	34	22.1	5.9
168	LTV	468	670	135	143.1	28.8
173	Magnavox	456	114	15	24.9	3.3
202	Collins Radio	388	216	14	55.8	3.6
223	Northrop	357	339	33	94.9	9.2
293	Teledyne	257	100	12	38.9	4.7
309	Lear Seigler	244	105	4	43.0	1.6
337	Fairchild Hiller	210	117	23	55.7	11.0
452	Curtiss-Wright	144	97	6	67.5	4.2

NOTE: The amounts of contracts have changed from year to year, and each year's amounts refer to contracts *let* rather than work performed. Moreover, these figures for prime contracts mask the substantial volume of subcontracting, which spreads the real production activity somewhat differently. In light of these points, this table is meant primarily to illustrate the general scope of the problem, not to show definitively its individual details.

SOURCES: Compiled from U.S. Defense Department, *100 Largest Prime Contracters* and *500 Largest R&D Suppliers*, NASA *Annual Procurement Report*; AEC, *Financial Report* (all Washington, D.C.: U.S. Government Printing Office, published annually); *The 500 Largest Industrial Corporations* (New York:

apparent in the table; nevertheless, note that federal contracts do constitute a sizable portion of the sales of many of the firms. The random distribution revealed is probably reflective of the fact that procuring agencies do not take the amount of sales by a firm into account during their procurement operation. The neglect of this factor may not be warrented in view of the trend toward concentration among manufacturing industries. Shepherd has stated that:

> Since the early 1950's, the effect that public procurement and research and development support have had toward greater market power /concentration/ has probably grown substantially. Against this increasing problem the Antitrust Division and FTC have had little direct or effective remedy.
>
> . . . the Division has had no effective basis even for knowing in advance, much less influencing, the impact that Defense Department and NASA purchases as well as contracts for research and development have had on a series of major "problem" industries. 27/

The implication is that the government's method of procurement is contributing to the development of the very economic concentration it wishes to discourage. Thus, the Joint Economic Committee, in the important and widely-read Need For More Competition in Defense Procurement, spoke only on the necessity for truly competitive procurements by DOD (and other agencies) in order to assure the greatest benefit/cost ratio for the government. 28/ But perhaps this policy of promoting competitive procurements should be combined with a policy of using procurement to promote competition. The final part of this paper will discuss some new areas for procurement research in light of this possibility.

Procurement to Promote Competition

There are a number of possible procurement policies which could promote competition. One of the more obvious policies would attempt to provide a greater emphasis on procurement from small business. To some extent this approach is already in effect. For example, the Small Business Act states that:

> "It is the declared policy of the Congress that the government should aid, counsel, assist, and protect, insofar as is possible, the interests of small business concerns in order to preserve free competitive enterprise . . . to maintain and strengthen the overall economy of the Nation. 29/

In pursuit of this goal, the Small Business Administration attempts to assure that a fair proportion of government procurements are let to small business. This is effected through the set-aside program, the breakout program, the Certificate of Competency program, and the subcontracting program.

Thus, in 1972 the efforts of the SBA and others resulted in small business receiving $12.6 billion in prime and subcontracts from the federal government, representing a 29% share of the total federal procurements let to American business in that year. 30/ This shift in emphasis from procurement from large corporations to procurement from small businesses mitigates the general trend toward economic concentration. A greater emphasis on procurement from small business would contribute further in this direction.

Alternatively, procurement policy could promote competition in areas other than strictly small business. For example, in some instances it may be possible to increase competition in an industry by the development and utilization of procurement criteria pertaining to medium-sized corporations. Such criteria might specify that procurement from conglomerates and vertically-integrated firms with substantial market power is to be avoided as much as possible. The criteria might also specify that procurement from leading corporations with large market shares (for example, over 15%) in industries characterized by a high four-firm concentration ratio (for example, over 60%) is likewise to be avoided as much as possible. Furthermore, procurement which might cause an increase in the four-firm concentration ratio in an industry could be discouraged or forbidden by such criteria. The consequence of adopting criteria pertaining to medium-sized corporations, then, would be to decrease or eliminate the amount of procurements let to the largest corporations in an industry, while at the same time increasing the amount of procurements let to medium-sized corporations below the industry leaders. Thus, procurement would contribute to the development of a trend where the market shares of the medium-sized corporations in an industry would increase at the expense of the larger market shares held by the leading corporations. Over the medium and long-range, government would promote economic competition by means of a carrot (procurement) rather than a stick (antitrust).

Another procurement policy which could promote competition would focus on the numerical scoring system used in many procurements. The system might be revised to include a factor in the scoring for "potential impact on competition." An example of such a scoring system follows:

Criteria	Points
(1) previous experience	300
(2) staffing plan	200
(3) management plan	300
(4) financial capability	150
(5) facilities and equipment	50
(6) potential impact on competition in this industry if this firm is awarded this contract	X

Such a scoring system assigns certain weights to certain criteria. Firms which bid on a contract are awarded points according to the extent that they meet the criteria, and those firms which fall into the competitive point range are those firms from which the final contract selection is made. Under the revised system here presented a new criteria (6) is incorporated into the scoring system. The weight to be assigned to this criteria is not established, but it would have to be large enough to give an advantage in procurement bids to firms with a relatively small share of the given market.

Tables 9 and 10 on the following two pages may help illustrate this system. Table 9 lists industries which sell heavily to the government, while Table 10 lists industries characterized by substantial concentration and market power. The two tables in conjunction are useful. For example, Table 9 demonstrates that computers and related machines are bought heavily by DOD and other public and regulated-utility purchasers. At the same time, Table 10 demonstrates that IBM has a 70-80% share of the computer market. Procurement agency use of the revised scoring system introduced above would be based on the premise that a concentration ratio of this degree generally impedes competition. Consequently, in a competitive procurement bid, IBM would receive few points under criteria (6), and would be handicapped in relation to smaller competitors. A computer firm with a small share of the market, then, might be listed first in the group of firms which reached the competitive range. The selecting official in the procuring agency would retain the discretion he now possesses to give the award to any firm in the competitive range, but account could be taken of criteria (6) and a procurement based on the points there obtained could be awarded when feasible. Thus, if procuring agencies in the past had procured from the smaller computer companies to the maximum extent feasible, IBM's share of the market might be less than it now is, and the Antitrust Division might not find it necessary to bring its present action against that company. If such a result could be caused by use of one of the procedures here outlined, then the additional economic analysis procurement agencies would be required to conduct may be warrented.

Certainly there will be some cases where the government must procure from a firm like General Motors. Occasionally only such large firms possess the physical overhead and technical knowledge needed to supply the quality and quantity of the goods the government needs. But in some cases, perhaps many, the government may be able to procure in a way designed to promote competition. Certainly it must be recognized that if the government does not procure in a way which will reduce concentration and promote competition, then it must procure in a way which will increase concentration and probably reduce competition. If this is the case, the government will contribute to the development of medium and long-range economic problems for the Nation. For as Senator Estes Kefauver once said, we are in danger of creating a "corporate socialism - a collective run by business and not government." 33/ But if such a socialism does arise the government may have to nationalize certain industries, thus causing more problems. Consequently, if the Nation

TABLE 9

INDUSTRIES SELLING HEAVILY TO PUBLIC AGENCIES AND REGULATED UTILITIES, 1966

Industry	S.I.C. Code Number	Value of ship-ments ($ m)	Major public-agency purchasers	Major regulated-utility purchasers
Highway construction	1611	(7,500)	Federal and State	
*Armaments	19	6,461	Defense Department	
Pharmaceutical preparations	2834	4,432	Defense, hospitals	
Explosives	2892	469	Defense	
Petroleum refining	2911	18,742	Defense	Airlines
Steel pipe and tube	3317	1,072		Natural gas
Nonferrous wire drawing and insulating	3357	3,711		Electric
Safes and vaults	3492	92		Banks
Fabricated pipe and fittings	3498	463		Natural gas
Steam engines and turbines	3511	867	TVA, federal power projects	Electric
Computing and related machines	3571	4,833	Defense, other departments	Airlines, Electric, telephone
Electrical measuring instruments	3611	1,020	Defense	Electrical
Transformers	3612	1,053	TVA, federal power projects	Electrical
Switchgear and switchboards	3613	1,549	TVA, federal power projects	Electrical
Current carrying devices	3643	811	TVA, federal power projects	Electrical
Noncurrent carrying devices	3644	673	TVA, federal power projects	Electrical
*Communications apparatus	366	10,030	Defense	Telephone, airlines
*Combat vehicles	37174	(400)	Defense	
*Aircraft, missiles, and parts	372	17,564	Defense	Airlines
*Shipbuilding and repairing	3731	2,239	Defense	
Locomotive and parts	3741	701		Railroads
Railroad and street cars	3742	1,695		Railroads
Scientific instruments	3811	749	Defense	
Optical instruments and lenses	3831	332	Defense	
Surgical and medical instruments	3841	360	Hospitals	
Surgical appliances and supplies	3842	769	Hospitals	
Photographic equipment	3861	3,286	Defense	
Research and development	7391	(5,000)	Defense	
Total		(96,873)		

NOTE: Figures in parentheses are estimates.
* Indicates that Defense "sole source" purchases (Chapter 5) are a substantial element in sales.
SOURCES: Adapted from Walter Isard and Gerald J. Karaska, *Unclassified Defense and Space Contracts: Awards by County, State and Metropolitan Area, United States, Fiscal Year 1964*, (Philadelphia: World Friends Research Center, 1965); and U.S. Bureau of the Census, *Annual Survey of Manufacturers, 1966*, M66(AS)-1 (Washington, D.C.: U.S. Government Printing Office, 1968).

TABLE 10

MAJOR AMERICAN MARKETS WITH SUBSTANTIAL MARKET POWER, 1968 (apart from utilities)

Markets and Leading Firms	Net Assets in $ million	Approximate Share of These Firms in Relevant Markets (Percent)
Industrial		
Telephone equipment		80–90
Western Electric	2,721	
Motor vehicles		90–100
General Motors	14,010	
Ford	8,953	
Chrysler	4,398	
Computers		70–80
IBM	6,743	
Heavy electrical equipment		70–80
General Electric	5,744	
Westinghouse	2,271	
Petroleum refining		40–50
Standard Oil (N.J.)	16,786	
Texaco	8,687	
Gulf	7,498	
Mobil	6,872	
Iron and steel		50–60
U.S. Steel	6,391	
Bethlehem	3,060	
Armco	1,633	
Republic	1,608	
Drugs		70–80
Am. Home Products	680	
Merck	488	
Pfizer	735	
Lilly	457	
Soaps, etc.		60–70
Procter & Gamble	1,612	
Colgate	531	
Lever	238	
Industrial chemicals		60–70
DuPont	3,289	
Union Carbide	3,209	
Dow	2,312	
Monsanto	1,895	
Aircraft engines		90–100
General Electric	5,744	
United Aircraft	1,358	
Aircraft		80–90
Boeing	2,186	
McDonnell-Douglas	1,335	
General Dynamics	866	
Flat glass		50–60
P.P.G. Industries	1,095	
Libby-Owens-Ford	385	
Aluminum		80–90
Alcoa	2,192	
Kaiser	1,371	
Reynolds	1,197	
Copper		60–70
Anaconda	1,685	
Kennecott	1,541	
Phelps-Dodge	654	
Photographic supplies		60–70
Eastman Kodak	2,565	
Tires and tubes		70–80
Goodyear	2,377	
Firestone	1,883	
Uniroyal	1,121	
Photocopying		70–80
Xerox	906	
Dairy products		60–70
Borden	1,023	
National Dairy	948	
Carnation	456	
Metal containers		80–90
American Can	1,337	
Continental Can	1,073	
Cereals		60–70
General Mills	505	
Kellogg	286	
Soup		90
Campbell	560	

is to avoid dominance by big business and/or big government, the development of policies which will promote the economy of many firms in effective competition with each other should proceed. Procurement has a role to play in this development, and research should be conducted to determine which procurement policies may be most appropriate. A policy successfully promoting economic competition can contribute towards more stable long-run pricing, faster technical innovation and productivity gains, a more optimum allocation of resources, and greater economic growth with a more equitable distribution of income. The Nation, the government, and the procurement agency all stand to gain.

FOOTNOTES

1/ William Shepherd, Market Power and Economic Welfare (New York: Random House, 1970), p. 16.

2/ Jules Blackman, "Holding the Reins on the Trust-Busters", in Antitrust Policy and Economic Welfare, edited by Werner Sichel (Ann Arbor, Michigan: Michigan Business Papers, University of Michigan, 1970), p. 18.

3/ John McGee, In Defense of Industrial Concentration (New York: Praeger Publishers, 1971), p. 135.

4/ Mark Green with Beverly Moore, Jr., and Bruce Wesserstein, The Nader Report: The Closed Enterprise System (New York: Grossman Publishers, 1972), p. 21.

5/ Phillip Blumberg, The Megacorporation in American Society (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1975), p. 20.

6/ William Leonard, "Mergers, Industrial Concentration, and Antitrust Policy", in Journal of Economic Issues (Vol. X, No. 2, June 1976), p. 355.

7/ John Blair, Economic Concentration (New York: Harcourt, Brace, and Janovich, Inc., 1972), p. 64.

8/ William Leonard, p. 356.

9/ John Blair, p. 13

10/ Ibid., p. 16

11/ William Shepherd, p. 106.

12/ John Blair, p. 534.

13/ William Shepherd, p. 191.

14/ Yale Brozen, "Concentration and Profits: Does Concentration Matter?" in The Impact of Large Firms on the United States Economy, edited by Fred Weston and Stanley Ornstein (Lexington, Massachusetts: D. C. Heath and Co., Inc., 1973), pp. 59-70.

15/ John Blair, p. 425.

16/ Alfred Kahn, "Market Power Inflation: A Conceptual Overview", in Roots of Inflation, with Gardiner Means, et al, contributors (New York: Burt Franklin and Co., Inc., 1975) p. 261.

17/ John Blair, p. 547.

18/ William Shepherd, p. 185.

19/ Mark Green, et al,, p. 14.

20/ William Scheirer, Small Firms and Federal Reserach and Development (unpublished report for Office of Federal Procurement Policy, 1976) p. 15.

21/ Mark Green, et al., p. 440.

22/ *Ibid.*, p. 14.

23/ *Ibid.*,

24/ Small Business Administration data.

25/ John Blair, p. 372.

26/ William Shepherd, p. 258.

27/ William Shepherd, "Changing Contrasts in British and American Antitrust Policies", in *Antitrust Policy and Economic Welfare*, p. 125.

28/ Joint Economic Committee, "The Need for More Competition in Defense Procurement", in *Monopoly Power and Economic Performance*, edited by Edwin Mansfield (New York: W. W. Norton and Co., 1974), pp. 210-214.

29/ Small Business Act.

30 Thomas Kleppe, "Introduction", in *The Vital Majority: Small Business in the American Economy*, edited by Deane Carson (Washington, D. C.: Government Printing Office, 1973), p. xv.

31/ William Shepherd, *Market Power and Economic Welfare*, p. 146.

32/ *Ibid.*, p. 152.

33/ Mark Green, et al., p. 29.

BIBLIOGRAPHY

(1) Blair, John M., Economic Concentration. New York: Harcourt, Brace, and Janovich, Inc., 1972.

(2) Blumberg, Phillip I., The Megacorporation in American Society. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1975.

(3) C rson, Deane, editor, The Vital Majority: Small Business in the American Economy. Washington, D. C.: Government Printing Office, 1973.

(4) Department of Commerce, Bureau of the Census, Concentration Ratios in Manufacturing Industry, 1972. Washington, D. C.: Government Printing Office, 1975.

(5) Federal Trade Commission, Economic Report on Corporate Mergers. Washington, D. C.: Government Printing Office. 1969.

(6) Green, Mark J., with Beverly Moore, Jr., and Bruce Wasserstein, The Nader Report: The Closed Enterprise System. New York: Grossman Publishers, 1972.

(7) Hearings on the Role of Giant Corporations in the American and World Economies, Subcommittee on Monopoly, Senate Select Committee on Small Business, 91st Congress, 1st Session, Part 1A. Washington, D. C.: Government Printing Office, 1969.

(8) Joint Economic Committee, "The Need for More Competition in Defense Procurement". Monopoly Power and Economic Performance, edited by Mansfield, Edwin. New York: W. W. Norton and Company, 1974.

(9) Kahn, Alfred E., "Market Power Inflation: A Conceptual Overview". Roots of Inflation, with Means, Gardiner, et al., contributors. New York: Burt Franklin and Company, Inc., 1975.

(10) Leonard, William, "Mergers, Industrial Concentration, and Antitrust Policy", in Journal of Economic Issues, Vol. X., No. 2., June 1976.

(11) Mansfield, Edwin, Microeconomics. New York: W. W. Norton and Company, 1970.

(12) McGee, John, In Defense of Industrial Concentration. New York: Praeger Publishers, 1971.

(13) Scheirer, William, Small Firms and Federal Research and Development. Unpublished report for Office of Federal Procurement Policy, 1976.

AN EXPERIMENTAL APPROACH TO PROCUREMENT POLICY RESEARCH

Charles Hulick and Joseph Berke
Procurement Programs
Experimental Technology Incentives Program
National Bureau of Standards

INTRODUCTION

Federal Procurement Policy in the present form does not encourage technological innovation. This is due to the fact that procurement policy, as outlined in the Federal procurement regulations, favors procurements made with maximum competition, using Federal specifications, and the awarding of contracts to the low acquisition price bidder. While these principles are designed to insure that Federal procurements will be made in an open, fair, and honest manner, they tend to result in the purchasing of products with the lowest common technological denominator. However, an organization known as the Experimental Technology Incentives Program (ETIP) is seeking to change this situation through the use of procurement incentives.

In his March 1972 Science and Technology and 1973 Budget messages, the President called for a testing of possible partnership arrangements among various Government levels, private firms and universities, and the initiation of a series of experiments to find better ways of stimulating private investment in research and development. This was the birth of the Experimental Technology Incentives Program known as ETIP.

This program, which is under the National Bureau of Standards, is part of a continuing effort, on the part of Federal Government, to find ways in which it can work as a more effective partner with the private sector of our society in the development, application, and transfer of science and technology to strengthen the Nation's economy and improve the quality of life.

The ETIP objective is to conduct an informed inquiry into the relationship between Governmental actions and technological innovation in the private sector. The purpose of the inquiry is to discover and test appropriate Governmental policies and practices which could stimulate desirable innovation in the civilian economy and thus contribute to the solution of national problems. The general method of conducting this inquiry is to work in close cooperation with appropriate Government agencies in the identification, analysis, testing, and evaluation of potential policy related incentives for innovation. The particular policies addressed will be of significant interest to the cooperating agency and will represent a general process which has application in other areas.

This experimental program is designed to gain insight into practical problems by developing unique information from actual experience to be used as the basis for policy recommendations.

ETIP is of course interested in fostering the adoption of the results of its inquiry, but it should be recognized, however, that responsibility for such implementation is beyond the province of ETIP.

The ETIP program consists of four major areas of policy research. These are Regulatory Policy, R&D Policy, Economic Assistance Policy and Procurement Policy.

THE ETIP PROCUREMENT PROGRAM

This paper deals with the work of the Procurement Program Area in identifying issues, designing and implementing experiments, and analyzing the results of new procurement policies and procedures on new products, innovation and technological change within Government and industry.

The hypothesis being tested is that Federal, State, and local governments can use procurement incentives to stimulate private sector technological innovation in products and services by providing an early market for innovative products and thus reducing market entry risks for suppliers. To properly test this hypothesis an array of suitable procurement incentives is being developed through continuous information interchange and interaction betweeen Government and industry.

These incentives are then tested in the realm of public procurement with appropriate support and participation from private sector suppliers or manufacturers.

Early in the ETIP program the experiments were chosen for ease of procurement, repeatability of procurement, interest to the participating agency and sufficiency of volume to ensure some measure of industry interest. These criteria allowed both ETIP and the participating agency to gain experience with setting up procurement experiments, establish lines of communication, and build credibility in the experimental approach to policy research. Many of these initial experiments are in their second or third procurement cycles and are considered to be generally successful. Details of these experiments will be presented later on.

ETIP PROCUREMENT EXPERIMENT CONSIDERATIONS

As the program evolved through experience and experimentation a more structured approach was developed to identify the issues and provide a forum for information interchange among and between all parties concerned with the product or policy issue. Before undertaking a specific procurement experiment with an agency several factors must be considered as follows:

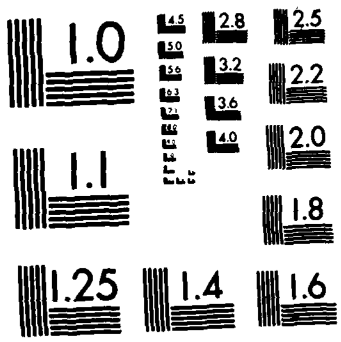
- The element of technology must be identified, whether it be energy conservation, higher performance, longer life or whatever. It should be clear at the outset exactly what is to be improved through the experiment.

- The technology element must be ranked and compared in both the Government and commercial markets to identify if the Government leads, lags behind or is even with the commercial market version of a product or product class.

- Agency goals with respect to the desired technology element need to be identified and established as part of the experiment. The ETIP goal of private sector technological innovation as the ultimate goal of the experiment is a long-range one; since the needs of participating agencies often require a more immediate payoff, products tend to be selected for experiments where the Government version of the product lags behind the commercial market version. The result is two sets of goals being established, short term and long term. In the short term, the agency goal is set at bringing the technology level of the product up to that of the commercial market. Once this has been achieved, the long term ETIP goal of private sector innovation through procurement incentives then becomes appropriate.

AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76 5/7

UNCLASSIFIED F/G 15/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

- Policy, procedural, traditional and other barriers to goal and technology achievement must be identified. Such barriers include risk of buying a product the customer agencies won't use, additional funds to cover the extra cost of a new product submitted in response to an incentive, and lack of properly trained personnel.

- ETIP resources, under the experimental framework can be directed toward developing an experiment to achieve goals and objectives while reducing barriers to innovation in the procurement process.

Once these factors have been considered the design of the procurement experiment begins. Here the ETIP procurement program staff works with the participating agency staff to obtain agency commitment for the duration of the experiment, design the details of the procurement incentive to be tested, if applicable, interact with industry and plan the evaluation of the experiment after each procurement. To aid in the issue development ETIP and Federal, State, and local agencies regularly conduct symposia on procurements. These symposia provided a forum for industry, the purchasing agent and the end user to discuss how best to interact to encourage industry to offer and the Government to buy new technology.

If new procurement incentives can work at the Federal levels, then an extension of new procurement incentives into State and local markets can also succeed. To test this hypothesis ETIP developed projects with the National Association of State Purchasing Officials (NASPO) and the National Institute of Governmental Purchasing (NIGP) to operate at State and local levels of procurement. For a product generic to three levels of Government there should logically be a consensus purchase description that is about 90 percent useable by all three levels of Government. Industry can be confident that products meeting purchase specifications at one level of Government stand a good chance of penetrating other Government markets due to consensus policies, procedures and purchase specification. Industry, on the other hand, will enjoy a more efficient communication link to the Government market for new products, ideas, modifications to existing products and so on. The formal arrangements for such an information service need to be developed. ETIP hopes to continue to identify such information needs and dissemination mechanisms through product and process experiments at all levels of Government. This is significant because our research of procurement at the State and local level indicates that the contractor community views the State and local market as being extremely fragmented, and thus not conducive to technological innovation and transfer.

RESULTS TO DATE

Work at the federal level testing procurement incentives has been with the Federal Supply Service, and the experiments have dealt extensively with a modified form of life cycle costing. The products chosen were in the consumer durable appliance product class (window air conditioners, refrigerators, water heaters, and kitchen ranges). In each case, test methods were utilized to obtain the energy consumption of the product which was then translated into operating cost for the estimated lifetime of the product. Other cost elements normally used in life cycle cost formulas such as maintenance and disposal value were considered but the lack of reliable data to document these elements precluded their use in these initial procurements. Procurement plans were designed to award contracts to the lowest total cost bid (bid price plus operating cost). Each project was designed to run for three successive procurement cycles (each cycle covering one year); thus far, two cycles have been completed. Net savings per unit purchased have been obtained by comparing the operating cost of the low life cycle cost bid (after adding in the additional costs of higher purchase price) with the operating cost of the low bid price unit. Contract savings to date total $3,842,053. While these cost savings are significant, the short term technology goal for these products has also been achieved in that the products being offered and purchased under these contracts are as good as what is available commercially. This sets the stage for future private sector innovation for these products since Government suppliers will now be encouraged to use these contracts as a means of introducing new products.

At the State and local levels of Government various procurements are in process using life cycle cost and performance criteria. Experiments show that consensus purchase specifications can be developed on generic products. Such specifications can increase industry interest and participation and over the long term provide some measure of incentive for technological change through aggregation of needs and markets.

Initially, during the first phases of both the NASPO and NIGP projects, the focus was to build a capability for conducting experiments and policy relevant research around specific products. The NASPO and NIGP activities are now beginning to concentrrte on presenting a more unified, aggregated and consensus arena for interaction with the innovation process.

WHAT LIES AHEAD

ETIP plans to conduct additional procurement experiments involving new policies and procedures at all levels of Government.

New incentives currently being considered are extended use of performance specifications, greater use of value incentive clauses to achieve product improvements after contract award and added life cycle costing experiments on products outside the traditional life cycle costing framework. Additionally, ETIP is sponsoring the design and implementation of a product improvement system at the Federal Supply Service. This system will formalize communications between user agencies, FSS, and the supplier community, and develop a framework for the use of procurement incentives in soliciting product innovations. ETIP is also identifying new agency partnerships for experiments involving warranties, innovative unsolicited proposals for product improvement, cost-plus incentive contracting to encourage innovation in traditional consumer items, and the effects of Federal policies on State and local procurements which use Federal grant dollars. These are but a few possible new experimental incentives. As others emerge, as industry suggests new ones and as the end user provides input, ETIP is prepared to consider experiments that will fulfill its objective of testing the effect of Governmental purchasing on innovation and technological change.

THE U.S. VERSUS THE SOVIET INCENTIVE MODELS*
SUMMARY

by

GREGORY G. HILDEBRANDT, MAJOR, USAF
Assistant Professor, Dept of Economics, Geography and Management
United States Air Force Academy

SEPTEMBER 1976

*The views expressed herein are those of the author and do not necessarily reflect the views of the United States Air Force or the Department of Defense. The author wishes to thank David Bradford, Martin Hellwig, and Laura D'Andrea Tyson of Princeton University for helpful comments and suggestions on earlier drafts.

Introduction

The central planning organizations of both the Soviet Union and the United States have been concerned with influencing the behavior of enterprises to achieve an improved allocation of resources. Although one is more likely to associate the central planning task with an economy such as the Soviet Union, the provision of many goods is centrally planned in the United States. For example, the Planning-Programming Budgeting System of the United States government can be viewed as part of a central planning process. This process frequently culminates in government acquisition of goods such as military hardware and space systems from private producers. Furthermore, the production technologies associated with many of these goods are not only highly uncertain, but are also more accurately known by the producers than by the government. Such goods as intercontinental ballistic missiles and manned space vehicles have embodied in them an advanced technology and an associated uncertainty about the conditions of production. This uncertainty is probably most pervasive during the engineering development phase of the "production" process when the performance characteristics of these goods are determined. The producers of these goods, however, will typically have a greater knowledge of this advanced technology and the impact of this technology on the conditions of production than does the government. Thus, the conditions of production are more uncertain for the government than for the producer at that time. The uneven impact of uncertainty implies that it is not possible for the government to specify the optimal output level.

A similar situation exists in the Soviet Union. The state enterprise may have better knowledge of its production technology than the planners, and the Soviet planners, therefore, may be unable to specify the optimal output level. Yet, both the U.S. and Soviet decision makers are concerned with creating an environment in which there are appropriate incentives to motivate producers to select the output level which is socially optimal at the time of producer decision making. Towards this end incentive systems have been developed in both the U.S. and the Soviet Union which reward producers for selecting the "right" output level.

In the United States this system has made use of the so-called "contractual incentive function" which specifies a mutually acceptable rule relating the monetary rewards of one decision maker to the subsequent performance of another. Numerous enterprises have devised profit-sharing formulae to motivate supervisory and managerial personnel, and the Department of Defense and NASA have relied on the use of performance incentives to monitor the work of major contractors. For example, performance incentives were included in contracts with a total value of several billion dollars during the U.S. moon program. Recent innovations in the use of performance incentives have appeared in the new Amtrak contract which relates payments to the railroads according to the quality of services they provide (2) and, in a contractual arrangement which guarantees a one percent increase in the salaries of the policemen of Orange, California to every three percent decline in rape, robbery, burglary and auto theft (6).

Although the existing literature on economic planning does not specifically mention the use of contractual incentive functions, a related concept has arisen in discussions of "success indicators" in Soviet planning. The Soviets have been notorious for their system of planning in which enterprise agents are rewarded according to the degree to which certain plan targets are achieved. By choosing enterprise targets and a related reward structure, Soviet planners have implicitly defined a performance incentive system. In contrast to similar systems employed in the West, the Soviet system has not been "contractual" in the sense that it has been agreed upon by the planners and the enterprise managers. Instead the state has unilaterally chosen the plan targets and rewards, and the enterprise managers have been expected to comply in an effort to attain their own maximum reward within the confines of the rules laid down by the planners. This "non-contractual" incentive system has been an example of the use of performance incentives in the implementation of economic planning.

Recently the Soviets have extended their incentive system to provide motivation for the state enterprises to select the optimal target or planned output level before the determination of the actual output. The importance of this additional incentive stems from the fact that if the central planners have a good estimate of the amount of the good which <u>will be</u> produced before it is <u>actually</u> produced, then a better coordinated plan can be achieved. There is a need for planners to coordinate outputs that are jointly used. Intermediate goods are used jointly in the production of final goods, and final goods are jointly consumed. The reason why an incentive is required to motivate the managers of the state enterprises to reveal the optimal target is that the enterprise may also receive a reward based on the actual output achieved in relation to the target output level. The existence of this reward may motivate the managers to understate the target output level if they are simply asked its value.

I. The New Soviet Incentive Model

The new incentive system has been analyzed by Martin Weitzman (7) using a model in which the resources or inputs available to the enterprise are fixed by the planners, but there is uncertainty associated with the output y that can be produced with these fixed inputs. The uncertainty rests with the producer, thus justifying the selection of the target output level by the enterprise.

Under the new system, a tentative target $\bar{y}$ and a tentative bonus fund $\bar{B}$ are assigned to the enterprise during the first or preliminary phase. The tenative target is the planner's best estimate of the target output level at that time. During the second or planning phase, the enterprise has the option of revising the tentative target to $\hat{y}$ which has associated with it a revised bonus fund $\hat{B}$ computed in accordance with the formula,

$$\hat{B} = B + \beta(\hat{y} - y),$$

where the constant β is proportional to the "real social value of having an extra unit which has been pre-planned" (7:256).

In the third or <u>implementation</u> phase, when the enterprise ends up producing amount y, it actually receives the bonus fund

$$B = \begin{cases} \hat{B} + \alpha(y - \hat{y}) : y \geq \hat{y} & \text{(overfulfillment)} \\ \hat{B} - \gamma(\hat{y} - y) : y < \hat{y} & \text{(underfulfillment)} \end{cases}$$

where α is proportional to the "real social value of having an extra unit unexpectedly delivered," and γ is proportional to the "real social cost of being unexpectedly caught short by one unit (7:256). It will be seen below that correct decision making by the enterprise requires that the constants β, α, and γ be in the same proportion to thei. respective value coefficients. Under the "old" Soviet incentive ..tem, $\hat{B}$ and $\hat{y}$ were fixed by the planners. Under the new system, they ..et by the enterprise.

Although the output actually achieved is not a choice variable when the inputs are fixed, Weitzman shows that the enterprise can use its knowledge of the uncertain conditions of production in conjunction with a specified performance incentive to select the optimal target output level. Letting P equal the probability that the output achieved during the implementation phase is at least as large as the target output, this target should be selected during the planning phase so that

$$P = \frac{\gamma - \beta}{\gamma - \alpha} .$$

This condition is shown to be formally equivalent to the cost minimizing rule that applies in inventory theory (5:136). The selection of $\hat{y}$ by the producer can be viewed as the selection of the amount of a good (the target) to be placed in inventory. The optimal rule insures that the costs associated with being short of the target and the costs associated with exceeding the target are minimized. The reason an inventory theoretic interpretation is interesting is that inventory theory is a well-developed framework and analogies that can be found with the planning process might prove fruitful in the development of a theory of economic planning.

Production inputs variable

Although Weitzman has chosen to view production inputs as fixed, largely because this reflects the Soviet planning environment, it is possible to extend his analysis by allowing the inputs used during the implementation phase to be choice variables of the enterprise with associated cost. This extension may have relevance to the Soviet planning problem now that the state enterprises are being given greater flexibility in the use of inputs. It is shown that the producer in selecting the target output level must now account for the impact of cost on the likelihood of being over target. However, once this adjustment is made, the producer's target output selection can be given the same interpretation as in the simple model.

II. The U.S. Incentive Model

The U.S. incentive model has as its purpose the motivation of producers to select an output level which is socially optimal. The DoD and NASA Guide states that

> the concept of multiple incentive contracting must quantitatively relate profit motivation directly and in accordance with the Government's objectives. . . . it establishes the contractor's profit in direct relationship to the value of the combined level of performance in all areas (3:107).

and that

> the process of including performance in an incentive structure must logically begin with the determination of the "value" of the characteristics which will be incentivized. The multiple incentive contract should reflect the importance to the government of various cost, schedule, and performance outcomes, through the profits assigned to each part of the multiple incentive structure (3:117).

Cost-effectiveness analysis

One method of describing the U.S. incentive model is to use a cost-effectiveness analysis approach. This approach is applicable when the government's objective is the achievement of some specified level of system performance at minimum cost and it can be used to facilitate comparison of the U.S. incentive model with the model used in the Soviet Union. It is assumed that increasing individual performance level p of some component of the system during the engineering development phase of procurement leads to future or "downstream" cost savings for the government because of reduced acquisition costs, maintenance costs, etc. The basic structure of the U.S. incentive model can be most easily illustrated if it is assumed that the producer is given a performance reward which is based on the level of p actually achieved and on development costs. Later, a more complicated model is developed to show how the U.S. incentive program can be expanded to incorporate the target selection features of the new Soviet incentive program.

I assume that the cost of development function, C(p), is deterministic during the implementation phase when the producer actually selects p. This function may, however, be known only to the producer. Indeed, for there to be a justification for using a performance incentive in the first place, there must be some uncertainty in the government's mind about the cost of development function at the time the incentive function is specified. Otherwise, the government would simply specify p. The downstream cost function, D(p), determines the costs borne by the <u>government</u> through the dependence on the output level selected by the <u>producer</u>. This function is assumed to be known by the government.

The profit or performance incentive function given to the producer under the U.S. incentive system is typically of the form

$$\pi = G(p) - sC \tag{1}$$

where G(p) represents dollars or profit earned as a function of the performance level p, and s equals the share of the development cost borne by the producer.

It is shown that the optimal incentive structure is obtained when the government constructs a performance incentive function such that

$$G'(p) = - s D'(p) \quad .$$

Thus, each unit of performance achieved by the producer should yield additional profit just equal to a proportion of the downstream cost savings where the factor of proportionality is the share of the development cost borne by the producer.

Extending the U.S. incentive model

For selected U.S. procurements in which the producer is the only supplier of a good whose performance is rewarded in relation to some target (thereby creating an incentive for the producer to understate the target if simply asked its level), there is value in extending the U.S. incentive program to include producer target specification. In addition to depending on the actual performance level, downstream costs are also dependent on the target performance level because of the time needed to prepare the operational environment (e.g., train maintenance people, etc.) for the performance level that is actually produced.

The profit function given to the producer is of the form

$$\pi = G(\hat{p}, p) - sC$$

where $\hat{p}$ is the target performance level and s again equals the share of the development cost borne by the producer. This function has the same basic form as (1) to retain compatibility with what has typically been used in the United States. It is shown that the additional requirement for an extended U.S. incentive system is that the incentive profit received by the producer for a change in the target performance level should just equal a proportion of the downstream cost savings. The factor of proportionality is again the producer's share of the development cost.

Conclusions

Decision makers in both the United States and the Soviet Union face similar problems of correctly guiding production at the enterprise level. To achieve certain social objectives, the United States government has employed the contractual incentive function whereas the Soviet planners have used the non-contractual or unilateral incentive function.

The new Soviet incentive system is designed to provide an incentive for the enterprise to reveal the socially optimal target output level. It has been shown that this system can be expanded to deal with the situation when the enterprise has control over the amount of resources utilized, a situation which is becoming increasingly typical in the Soviet Union and which continues to be the norm in the United States. Although the option of placing an incentive on the target output level has not yet been utilized in the United States, the existing U.S. incentive system can be expanded to permit that possibility. Like the Soviet planners, U.S. decision makers are concerned with the achievement of well-coordinated production levels.

References

1. Ackerman, D. and Krutz, R. "Structuring of Multiple Incentive Contracts." USAF Academy Working Draft, May 1966.

2. Baumol, W. J. "Payment by Performance in Rail Passenger Transportation: An Innovation in Amtrak's Operations." Bell Journal of Economics (Spring 1975), 281-299.

3. DoD and NASA Guide. Incentive Contracting Guide. October 1969.

4. Hildebrandt, G. and Tyson, L. "Performance Incentives and Planning Under Uncertainty." Econometric Research Program Research Memorandum No. 201, Princeton University, July 1976.

5. Naddor, E. Inventory Systems. John Wiley and Sons, Inc., 1966.

6. The Trenton Times. Sunday, December 15, 1974.

7. Weitzman, M. "The New Soviet Incentive Model." Bell Journal of Economics (Spring 1976), 251-257.

ENCOURAGING INNOVATION AND TECHNOLOGY TRANSFER FOR NEW PRODUCT DEVELOPMENT: THE FEDERAL SUPPLY SERVICE PRIM SYSTEM

by
James B. McNallen *PhD
Peter C. Boulay, ** and
Theodore J. Fody ***

*Marketing Research Specialist, Market Research and Marketing Division
Office of Customer Service and Support, Federal Supply Service
General Services Administration, Washington, DC 20406

**Director, Market Research and Marketing Division,
Office of Customer Service and Support
Federal Supply Service
General Services Administration
Washington, DC 20406

***Director, Experimental Technology Division
Office of Management Planning and Program Analysis
Federal Supply Service
General Services Administration
Washington, DC 20406

Presented to
Session #6: Technology Incentives
Fifth Annual Department of Defense Research Conference on
PROCUREMENT RESEARCH AND ACQUISITION STRATEGY
U S. Naval Postgraduate School
Monterey, California
November 18, 1976

ENCOURAGING INNOVATION AND TECHNOLOGY TRANSFER

FOR NEW PRODUCT DEVELOPMENT:

The Federal Supply Service PRIM System

by James B. McNallen, Peter C. Boulay, and Theodore J. Fody

ABSTRACT

The business of the Federal Supply Service of the General Services Administration is to provide and sell common-use, nonpersonal products to other federal departments, agencies and bureaus. Most products sold by Federal Supply are essentially standard and have a low-technology content.

Manufacturers supplying these products visualize an extended life-cycle for their products and few technology changes or product improvements. Traditionally, most government procurement has focused on design specifications and purchasing products on a least-cost basis. Thus, there has been little incentive for manufacturers to provide new or improved products for government markets.

The Federal Supply Service does not have a research and development or product development function as currently organized. The proposed PRIM System (acronym for Product Improvement Intervention System) was recently developed by an outside contractor. Its purpose is to try to encourage private sector vendors of these products to undertake efforts at innovation new technology, and technology transfer to develop new and improved products. In exchange, the Federal Supply Service would provide a number of incentives, including purchase of these products for resale to its customer agencies and help in establishing the new and improved products' viability for successful commercial introduction in private sector markets.

The two objectives of the Federal Supply Service PRIM System are: (1) to provide new and improved products to its own $1.5 billion annual market represented by government agencies buying centrally; and (2) to encourage growth and the economic vigor of the private sector firms that offer these products to Federal Supply.

The Federal Supply Service PRIM System is based on innovation theory, diffusion theory of new ideas, concepts and products, and technology-transfer theory. The system assumes that incentives can be provided across a wide range of product development activities involving innovation, diffusion, and technology-transfer. It also assumes that these incentives can be tailored to assist and encourage private sector firms to emphasize these areas.

Four subsystems comprise the Federal Supply Service PRIM System: (1) the Suggestion Subsystem; (2) the Procurement Techniques Subsystem; (3) the Implementation Subsystem; and (4) the Assessment Subsystem.

The Suggestion Subsystem is designed to elicit ideas for needed new products and product improvements from a variety of sources. These suggestions are solicited in areas determined by Federal Supply management. Methods of soliciting ideas include distribution of product idea kits, sponsorship of product improvement and procurement technique seminars, and surveying customers and potential customers. A series of screening criteria are used to narrow the suggestions to those most likely to prove successful.

The Procurement Techniques Subsystem is intended to provide proven procurement techniques for spurring innovation, new technology, technology transfer, new product development, and product improvements. The subsystem also provides for developing new procurement techniques, or combinations of techniques. Some will serve particular product or commodity areas while others may serve particular types of present or prospective suppliers (e.g., small or minority businesses). This subsystem matches procurement technique as an incentive to the particular product or commodity area selected for further development.

The Implementation Subsystem visualizes using the Federal Supply Service's buying power, marketing, communications and distribution system in experiments to help participating private sector firms test the demand for their new or improved products. This would be done by running experiments to test the demand for the product concept and delivery and its acceptability for use by Federal Supply's customer agencies.

The Assessment Subsystem provides for current-information feedback and evaluation of the success of the marketing experiment. Experiments, generally, run for one year. During this period, quarterly progress reports would be provided. A final evaluation report would be prepared at the conclusion of the experiment.

The various parts of the Federal Supply Service PRIM System would be integrated through a manager who would report to a PRIM Management Board, comprised of senior executives of the Federal Supply Service. The board would choose the product areas to be emphasized, decide on the ideas or concepts for further development, determine policy for conducting experiments, and provide the final evaluation of these experiments.

\- - - - - - - - - - - - - - -

<u>Introduction</u>

The Federal Supply Service PRIM (acronym for Product Improvement Intervention) System was developed to encourage private enterprise to develop and market new and improved common-use products and to speed the commercial application of available new technology. The system assists business firms by providing an initial source of demand for the product while still in the embryonic stage, by providing test markets for determining buyer and consumer reaction to the product, and by helping define a potential, continuing market.

The Federal Supply Service, as currently organized, does not have a research and development or product development function. In addition, there is no comprehensive procedure for the systematic review of all products and product lines carried by Federal Supply. The PRIM System may represent a bonus by providing Federal Supply management with a rational tool for accomplishing these objectives.

The Federal Supply Service PRIM System is an outgrowth of the Experimental Technology Incentives Program (ETIP) of the National Bureau of Standards. The ETIP Program is an effort by the federal government to encourage innovation and the technological change by using the federal purchases of goods and services to encourage private enterprise to develop new and improved products. These new and improved common-use products will benefit not only the federal government but also the economy as a whole, and business, industrial and individual consumers as these products are diffused into commercial markets. The ETIP Program dates from June 9, 1973, when the President sent legislation to Congress proposing the establishment of an Office of Science and Technology Policy in the Executive Office of the President. The legislation was passed by Congress in early November and signed into law by the President.

The Federal Supply Service (FSS) of the General Services Administration (GSA) was designated the lead agency of the federal government to experiment with incentives under ETIP. The reason for this selection is that the Federal Supply Service aggregates the purchasing power of virtually all agencies of the government for common-use, non-personal items in order to achieve the economies of large purchases. These economies are passed on to the customer-agency in the form of lower prices. In addition, the Federal Supply Service provides a centralized procurement and supply system to simplify administrative procedures and manpower and processing costs. The Federal Supply Service is, of course, concerned to provide high quality products which meet customer-agency needs and desires. Their aggregated purchasing power results in FSS procurement of approximately one and a half billion dollars worth of goods annually from the private sector and FSS-sales of approximately the same magnitude.

The underlying purpose of the PRIM System is to develop cooperation between industry and government to achieve mutually beneficial objectives and to serve national economic and environmental goals.

The Federal Supply Service quickly mobilized its resources to cooperate with the Experimental Technology Incentives Program. A contract was awarded on September 15, 1975, after reviewing competitive bids from nine firms, to Organizational Resources and Systems Advisors, Inc. (ORSA). Their bid included provision for parts of the contract to be fulfilled by three subcontractors, viz, the Gallup Organization of Princeton, New Jersey; Battelle Memorial Institute of Columbus, Ohio; and Professional Associates of Organization Science, of Washington, DC.

This paper is a report on the results of the work of ORSA and its subcontractors. Co-author Peter C. Boulay, Director of the Market Research and Marketing Division of the Office of Customer Service and Support, was designated Project Officer by the Commissioner of the Federal Supply Service of GSA. Co-author Theodore J. Fody, Director, Experimental Technology Division of the Office of Management Planning and Program Analysis, has had a key role in the project since its inception. The presenter was a member of a six-person Management Board which had day-to-day supervision and direction of the project and advised the Project Officer. This paper presents highlights of the final report on this effort, which was completed July 30, 1976 (General Services Administration, 1976, PRIM System Handbook). It should be noted that the ultimate goal of the government's role in encouraging innovation and technology transfer for new product development -- including any procurements used as incentives -- is and must be the stimulation of a new commercial market, not just the development of an exclusive government market.

Innovation, Diffusion and Technology Transfer

The Federal Supply Service PRIM System is founded on the theory of the diffusion of innovations and the theory of new product development.

There are several theories of the innovation process. These have been classified regarding the source of the innovation as follows:

a. Transcendalist theory states that innovation is due to inspiration, usually involving a single individual;

b. Mechanistic theory asserts that innovation is the result of an accumulation of items, mostly small, over a long period of time; and

c. Cumulative-synthesis theory combines these first two theories and states that innovation is the result of both novelty items (new ideas, inspirations) and familiar items which have been collected over time. (Robertson, 1967)

Innovation can also be classified in terms of time and effect on existing organizations and behavior patterns as follows:

a. Incremental continuous innovation focuses on small changes and minor alterations in existing products (e.g., going from a 100 mm to 120 mm length of cigarette). This type of innovation is hardly or only mildly disruptive of the social and economic fabric, causing minor changes in organizational and personal behavior.

b. Dynamic continuous innovation involves significant change or alteration of an existing product (e.g., shift from the dial to touch-tone telephone, the decision to manufacture a new generation of computers, or manufacture a jumbo jet passenger aircraft). This type of innovation is somewhat disruptive, causing significant shifts in organizations and personal behavior.

c. Discontinuous innovation involves not only a new product but also the establishment of new ways of arranging behavior patterns (e.g., invention of the railroad, automobile, television, computer, Polaroid camera, plastic, xerox copier, CB radio, weather satellite) (Robertson, 1967). This type of innovation can be very significant, and cause major changes in the social and economic organization of society and in behavior patterns.

The literature indicates that business firms, for the most part, tend to stress mechanistic theory and the results are considered, or at least advertised, as a new or improved product.

The Federal Supply Service PRIM System proposes to work with business firms in terms of (a) the mechanistic and cumulative-synthesis theories of innovation; and (b) the incremental-continuous and dynamic-continuous innovation processes. In other words, the PRIM System focuses on cooperation with business firms in a way that will be comfortable for them, as well as Federal Supply, and which, hopefully, will result in the development of "new" or "improved" products as generally viewed by businessmen (Kotler and Zaltman, 1971).

There are several reasons for this:

1. Federal Supply Service's role is to encourage business firms to be more innovative in their own interest, as well as in the interest of the federal government and the national economy.

2. Federal Supply's general area of operations involves mostly common-use, low-technology products; there seems to be limited opportunity for quantum jumps in new technology and the development of truly fresh and unique products in these areas.

Once an innovation appears, regardless of type, there is the problem of gaining acceptance. Everett Rogers has made the major contribution in the area of diffusion theory (Rogers 1962, 1971, 1975, 1976).

The "classical model" of the diffusion of new ideas has four main elements; (1) the <u>innovation</u>, defined as an idea, practice, or objective perceived as new by an individual or other relevant unit of adoption, (2) which is <u>communicated</u> through certain <u>channels</u>, (3) over <u>time</u>, (4) among the members of a <u>social system</u> (Ryan and Cross, 1943).

The diffusion of innovations takes place, generally, in an orderly sequence. Exhibit I shows Rogers' model (1962) of the diffusion process. This has been tested and replicated many times for all kinds of products, processes, and new ideas.

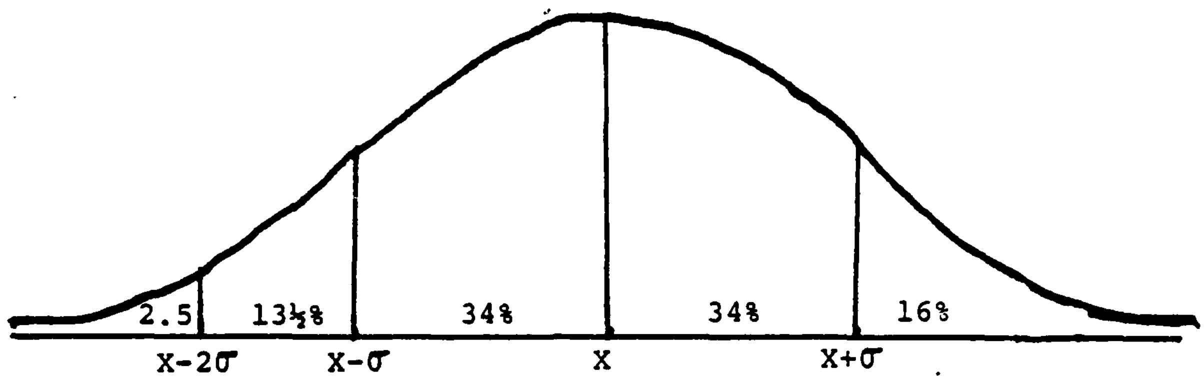
In general, Rogers' model (Exhibit I) breaks the diffusion process into five phases or stages of trial and/or acceptance by various groups in a potential market or universe as follows:

<u>Phase I</u> - The innovators, arbitrarily defined as the first 2.5 percent of the population that are most likely to try a new product, process or idea in a particular area.

<u>Phase II</u> - The early adopters, defined as the next most likely group to try an innovation. They constitute 13.5 percent of the population, and are influenced by the innovators to try and accept or reject an innovation, whether a new product, process, or idea.

EXHIBIT 1

DIFFUSION OF INNOVATION



Innovators	2.5%
Early Adopters	13.5%
Early Majority	34.0%
Late Majority	34.0%
Laggards	16.0%

SOURCE: Everett M. Rogers, Diffusion of Innovation, (New York: The Free Press of Glencoe, 1962), p. 162.

Phase III - The early majority, constituting 34.5 percent of the population, are influenced by the early adopters and are the next most likely group to try and accept or reject an innovation.

Phase IV - The late majority, comprising the next 34.5 percent of the population, are influenced by the early majority to try and accept or reject an innovation.

Phase V - The laggards, comprising 16 percent of the population, may eventually try and accept or reject an innovation.

This classification is clearly based on the characteristics of willingness to seek out and accept change and new or improved ways of doing things. As an innovation travels through the diffusion process, it also passes through its life cycle.

A whole literature has grown up in marketing based on the concept of the life-cycle of a product, and in the private sector, marketing, advertising, promotion and pricing decisions for both consumer and industrial products are based on diffusion theory as shown in Exhibit 2 (Wasson, 1974).

Relevant to the PRIM System, Rogers' model states that diffusion takes place slowly in the first two phases (innovators and early adopters). Then, as it reaches phase three (early majority), the product's or innovation's acceptance and sales take on a "bandwagon" effect.

The purpose of the PRIM System, in essence, is to try to move the Federal Supply Service, in commodity areas selected by management, from the "early majority" or "late majority" phases into phases I and II, the innovators and early adopters. Thus Federal Supply could help private firms achieve success with their own innovation efforts to introduce new products or significant product improvements by getting the product tested and accepted in government markets. This should help them achieve commercial success on the open market. This is not easy, but it is the objective of the PRIM System. It is believed that the PRIM System would benefit Federal Supply by making it a more dynamic and responsive marketer in serving its limited market of customer-government agencies, and help the private sector and the national economy by encouraging economic growth.

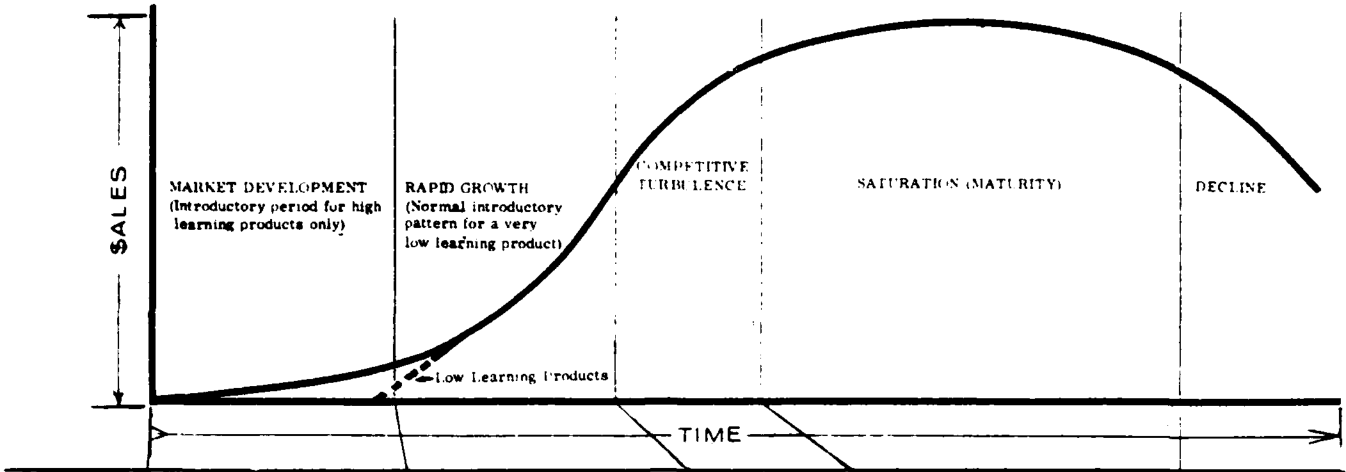
The difference between the innovation process and technology transfer is that innovation processes tend to deal with the spread, or diffusion, of an item over time, while technology transfer has emphasized the point-to-point transfer mechanism. (Chakrabati, 1973). However, the two processes are not mutually exclusive. Exposition of the innovation process provides a sound foundation for the development of the technology transfer process.

A five step methodological procedure for promoting technology transfer has been developed as follows:

Step I. A resource base must be developed which reflects market needs and opportunities and research capabilities and possibilities. This information must be categorized for each reference and updated to facilitate the next two steps.

EXHIBIT 2

DYNAMIC COMPETITIVE STRATEGY & THE MARKET LIFE CYCLE



	MARKET DEVELOPMENT	RAPID GROWTH	COMPETITIVE TURBULENCE	SATURATION (MATURITY)	DECLINE
STRATEGY OBJECTIVE	Minimize learning requirements, locate and remedy offering defects quickly, develop widespread awareness of benefits, and gain trial by early adopters	To establish a strong brand market and distribution niche as quickly as possible	To maintain and strengthen the market niche achieved through dealer and consumer loyalty	To defend brand position against competing brands and product category against other potential products, through constant attention to product improvement opportunities and fresh promotional and distribution approaches	To milk the offering dry of all possible profit
OUTLOOK FOR COMPETITION	None is likely to be attracted in the early, unprofitable stages	Early entrance of numerous aggressive emulators	Price and distribution squeezes on the industry, shaking out the weaker entrants	Competition stabilized, with few or no new entrants and market shares not subject to substantial change in the absence of a substantial perceived improvement in some brand	Similar competition declining and dropping out because of decrease in consumer interest
PRODUCT DESIGN OBJECTIVE	Limited number of models with physical product and offering designs both focussed on minimizing learning requirements. Designs cost- and use-engineered to appeal to most receptive segment. Utmost attention to quality control and quick elimination of market-revealed defects in design	Modular design to facilitate flexible addition of variants to appeal to every new segment and new use-system as fast as discovered	Intensified attention to product improvement, tightening up of line to eliminate unnecessary specialties with little market appeal	A constant alert for market pyramiding opportunities through either bold cost- and price-penetration of new markets or major product changes. Introduction of flanker products. Constant attention to possibilities for product improvement and cost cutting. Reexamination of necessity of design compromises	Constant pruning of line to eliminate any items not returning a direct profit
PRICING OBJECTIVE	To impose the minimum of value perception learning and to match the value reference perception of the most receptive segments. High trade discounts and sampling advisable	A price line for every taste, from low-end to premium models. Customary trade discounts. Aggressive promotional pricing, with prices cut as fast as costs decline due to accumulated production experience. Intensification of sampling	Increased attention to market-broadening and promotional pricing opportunities	Defensive pricing to preserve product category franchise. Search for incremental pricing opportunities, including private label contracts, to boost volume and gain an experience advantage	Maintenance of profit level pricing with complete disregard of any effect on market share
PROMOTIONAL GUIDELINES — Communications Objectives	a) Create widespread awareness and understanding of offering benefits b) Gain trial by early adopters	Create and strengthen brand preference among trade and final users. Stimulate general trial	Maintain consumer franchise and strengthen dealer ties	Maintain consumer and trade loyalty, with strong emphasis on dealers and distributors. Promotion of greater use frequency	Phase out, keeping just enough to maintain profitable distribution
Most valuable media mix	In order of value: Publicity, Personal sales, Mass communications	Mass media, Personal sales, Sales promotions, including sampling, Publicity	Mass media, Dealer promotions, Personal selling to dealers, Sales promotions, Publicity	Mass media, Dealer-oriented promotions	Cut down all media to the bone--use no sales promotions of any kind
DISTRIBUTION POLICY	Exclusive or selective, with distributor margins high enough to justify heavy promotional spending	Intensive and extensive, with dealer margins just high enough to keep them interested. Close attention to rapid resupply of distributor stocks and heavy inventories at all levels	Intensive and extensive, and a strong emphasis on keeping dealer well supplied, but with minimum inventory cost to him	Intensive and extensive, with strong emphasis on keeping dealer well supplied, but at minimum inventory cost to him	Phase out outlets as they become marginal
INTELLIGENCE FOCUS	To identify actual developing use-systems and to uncover any product weaknesses	Detailed attention to brand position, to gaps in model and market coverage, and to opportunities for market segmentation	Close attention to product improvement needs, to market-broadening chances, and to possible fresh promotion themes	Intensified attention to possible product improvements. Sharp alert for potential new inter-product competition and for signs of beginning product decline	Information helping to identify the point at which the product should be phased out

NOTE: Strictly speaking, this is the cycle of the category market, and only a high learning introduction passes through all phases indicated above. The term, product life cycle, is sometimes applied indiscriminately to both brand cycles and category cycles. Most new brands are only emulative of other products already on the market, have a much shorter life cycle than the product category, and must follow a strategy similar to any low-learning product.

<u>Step II. Market needs and wants</u> information involves a search for a new market or opportunity for new technology, as well as the possible transfer application of existing technology to new markets.

<u>Step III. Matching</u> seeks to match technological capabilities with opportunities in the market place.

<u>Step IV. Evaluation and selection</u> focuses on the potential size and profitability of the market for the newly developed or existing technology, leading to a decision on whether to proceed in this area.

<u>Step V. Exploitation</u> involves the development of prototypes, test marketing, and adaptive engineering to determine whether the new product will be or can be made into a success. This step also requires ascertaining whether the product can be a commercial success in terms of the depth of market needs, timing and profitability (Foster, 1971; Trippi and Wilson, 1974; Buttner, 1968).

The Federal Supply Service PRIM System provides an instrument of cooperation, within legal limits, to work with business firms in this process.

The New Product Development Process

Peter Drucker (1974) says that the purpose of a business is to create a customer. And, he says, because its purpose is to create a customer, the business enterprise has two -- and only these two -- basic functions: marketing and innovation. The job of marketing is to create the customer, while the job of innovation is to create the product or service or combination of the two to meet the customers' needs and wants.

Most business and industrial firms have adopted a systematic approach to new product development and commercialization. The new product development model developed by the consulting firm of Booz, Allen and Hamilton is perhaps the best known. A part of the model is a three by three conceptual matrix to assist management in matching company objectives in the area of technology with its marketing objectives (Johnson and Jones, 1972).

The Booz, Allen, Hamilton model involves a six stage process for new product development. These six steps and/or stages in the Booz, Allen, Hamilton model (Uman, 1969) are:

- exploration
- screening
- business analysis
- development
- testing
- commercialization

Kotler (1972) has provided a graphic representation of this six stage process (Exhibit 3) which differs only slightly from the Booz, Allen, Hamilton model. The Federal Supply Service PRIM System is intended to assist business management through the first five stages of this process and help the firm prepare for stage six. Logically, the end of each stage presents a point requiring a managerial decision on whether to continue the project. This decision would be made by the business firm.

The Kotler six-stage new product development model can be broken into phases. Phase I, idea generation, is primarily creative, and may be the most difficult. Phase II, analysis and evaluation, comprises the five stages that follow idea generation. These five stages are: screening, business analysis, product development, test marketing, and commercialization.

There are both external and internal sources for idea generation for a new product. As regards external sources (Exhibit 4), the Federal Supply Service PRIM System would focus on only three:

- Customers/Consumers
- Distributors
- Technological Information Exchanges

Each individual firm would decide whether to contact and/or make use of the other three sources for generation of new-product-ideas, i.e., competitors, advertising agencies, and new product development firms.

Each of FSS's external sources for idea generation will be examined in turn.

Consumers: For purposes of this paper, consumers and customers or purchases are assumed to be identical. Actually, this is correct if the customer or consumer is considered to be an institution, although this is not correct literally. For example, a military command or installation supply officer may be the purchaser of office equipment or furniture, and hence the customer, but the consumer could be a GS-4 secretary or E-3 enlisted person. There may be, and frequently are, several intermediaries between ultimate consumer and the purchaser. However, for purposes of PRIM, the two will be considered the same.

A new product should be designed to satisfy consumer wants and needs. New product ideas, today, must be congruent to the needs, and values of consumers and to environmental requirements (Normann, 1971).

Curiously, most companies rely solely on internal sources, such as research and development, for new product ideas. Thus many new products are developed without taking the customer's needs into account. Yet, many studies have shown that one of the major reasons for the failure of new products to achieve successful commercialization has been the lack of a strong market orientation toward consumers' needs and wants (Buskirk, 1975).

EXHIBIT 3

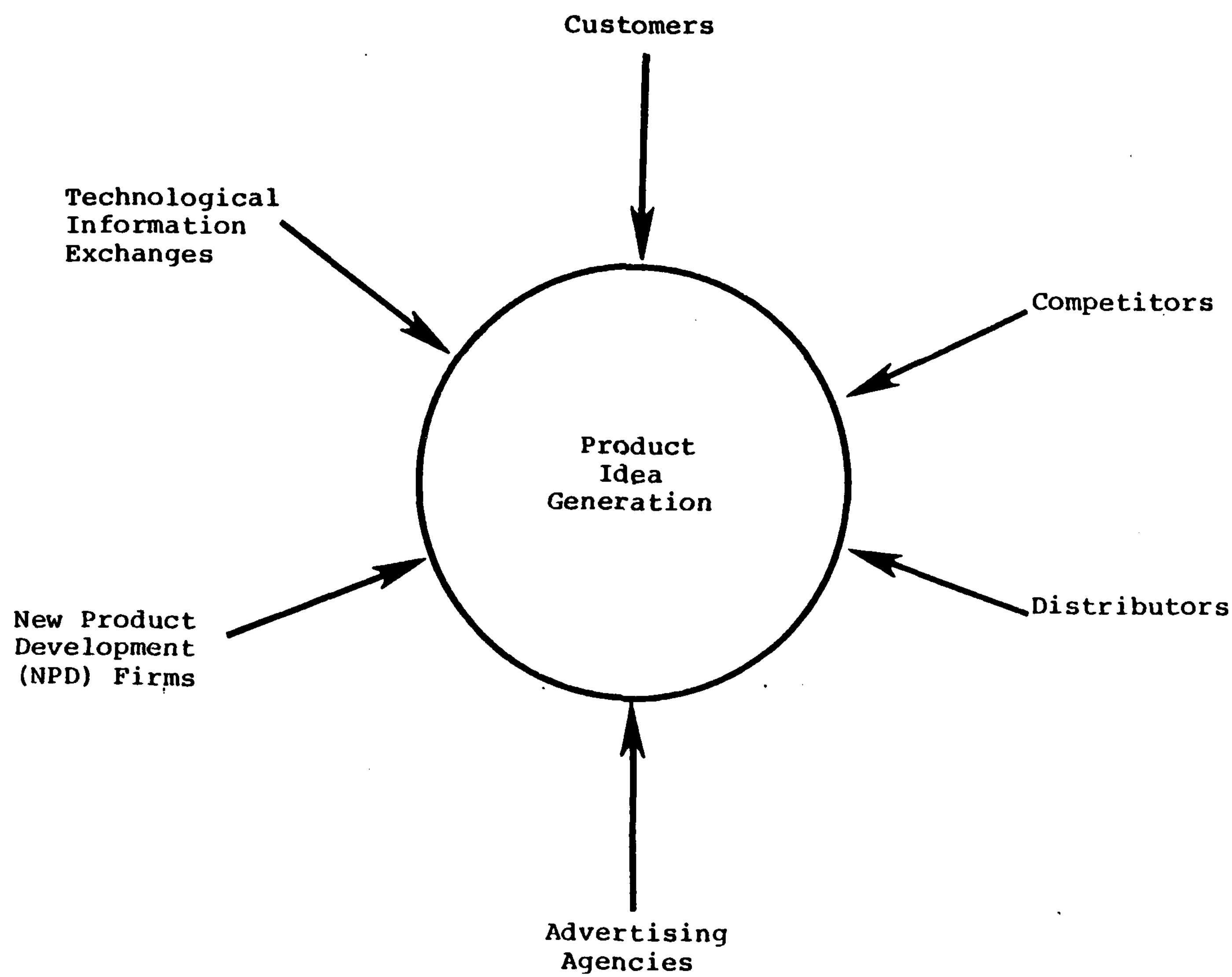
STAGES IN NEW PRODUCT DEVELOPMENT

PHASE I	PHASE II				
IDEA GENERATION	ANALYSIS AND EVALUATION				
1. Idea Generation-Is the particular idea worth consideration? →	2. Screening- Is the product compatible with company objective s needs, and resources? →	3. Business Analysis- Is it likely that this product will meet our profit goals? →	4. Product Development. Have we developed a product that is sound both technically and commercially? →	5. Test Marketing. Have product sales met out expectations? →	6. Commercialization. Are product sales meeting our expectations?

Source: Philip Kotler, Marketing Management: Analysis, Planning and Control, Englewood Cliffs, N.J.; Prentice Hall, Inc.,(1972) p. 505.

EXHIBIT 4

EXTERNAL SOURCES OF IDEAS



This is one of the areas where the Federal Supply Service PRIM System can significantly and materially assist business firms - first, by soliciting ideas from customers, and secondly, by helping firms run customer tests of new product ideas.

Competitors: This source involves the search and investigation of new products being developed by other firms. Obviously, this is not an appropriate area for involvement of the Federal Supply Service PRIM System. Nevertheless, contacts between firms and individuals in the same industry through seminars and conferences tend to have a synergistic effect: the more innovation- and customer-oriented a firm or its management becomes, and the more information obtained, the more likely a firm is to become a successful innovator in the new product area. The Federal Supply Service PRIM System can sponsor seminars, conferences, market research studies and speakers stressing new products, innovation and technology transfer. This is an appropriate activity for a government agency and can help competitive firms mutually cross-pollinate each other with new product ideas.

Distributors: The Federal Supply Service sold approximately $1.3 billion worth of common-use, relatively low-technology goods to other government agencies in Fiscal Year 1976, and forecasts $1.5 billion in sales for Fiscal Year 1977.

Thus Federal Supply acts as a billion-dollar middleman or distributor of goods purchased from the private sector for resale to other federal government agencies. Regional operations serve as distribution points for these goods. Distributors, in general, represent a significant potential source of product suggestions because of their function as an interface between the purchaser or ultimate customer/consumer and the manufacturer.

While Federal Supply was founded in 1949, its Market Research and Marketing Division in the Office of Customer Service and Support has been in existence only since 1974. As of today, this function of developing information from customers which could be helpful to manufacturers has not been fully developed. The Federal Supply Service PRIM System is a start in realizing this potential.

Three possiblities exist for Federal Supply in performing this function:

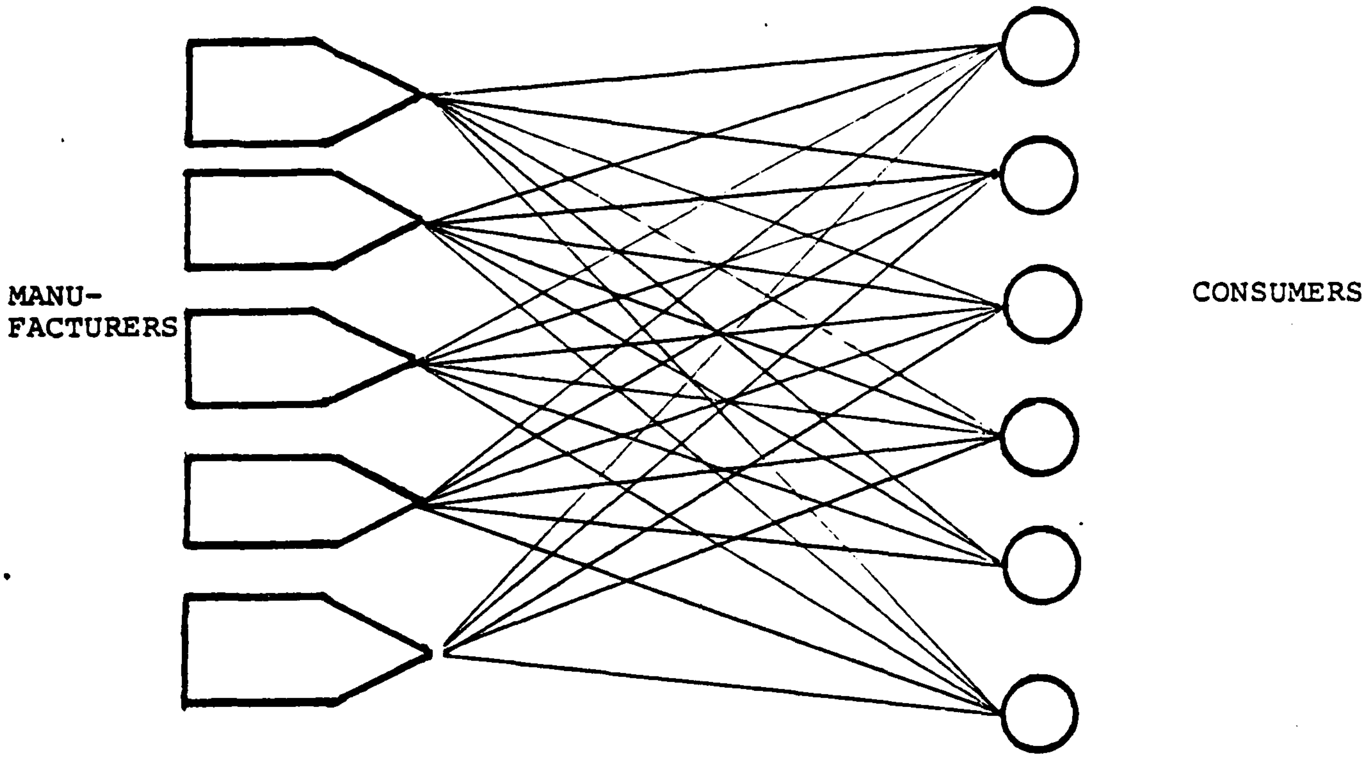
- Provide information about customer requests received which they have been unable to fill. This could identify new or changing or overlooked customer needs or requirements which are not being adequately filled by current product offerings.

- Survey customers to determine their opinions and attitudes toward present products and obtain suggestions for new and improved products.

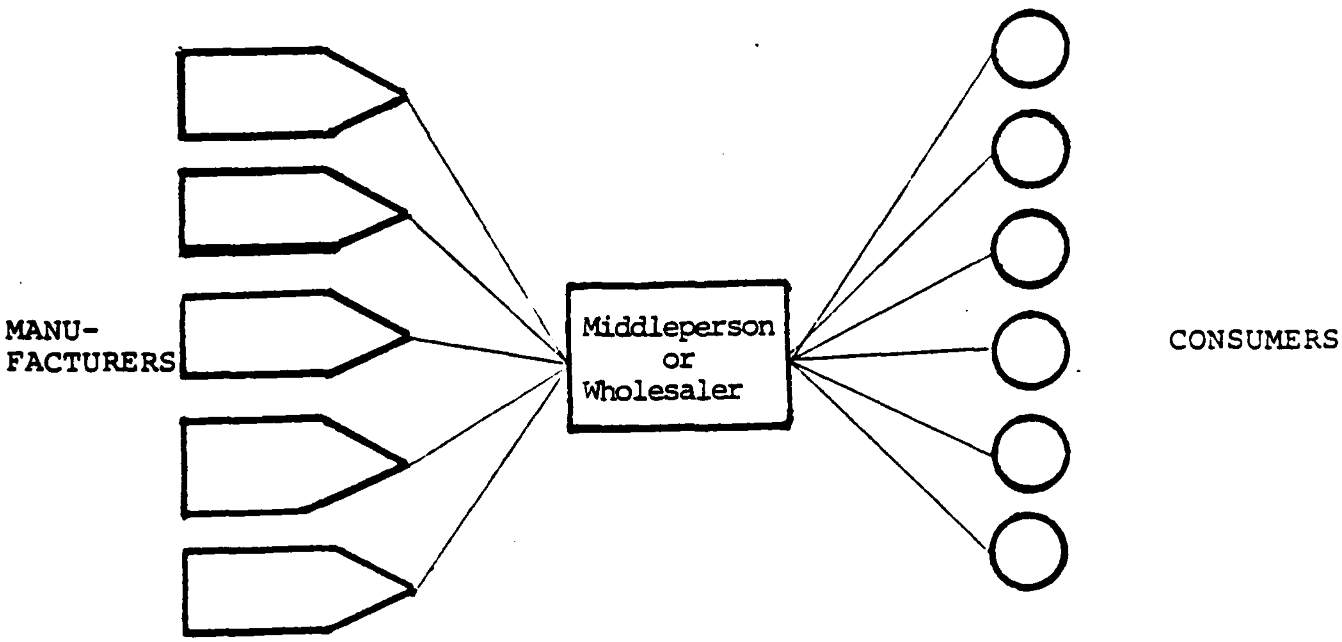
- Careful analysis of customer complaints may identify special problem areas which, in turn, could lead to product changes or improvements or even totally new products (Buskirk, 1975). Exhibit 5 shows the informational values of these kinds of data gathered by a distributor even when there are relatively few manufacturers or suppliers of goods and few customers (Enis, 1974). Federal Supply Service has approximately 30,000 vendors on the bidders mailing list and over 133,000 customers on its address code list, so it is clear that the value of the service is enhanced many times over by the size of Federal Supply operation.

EXHIBIT 5
INFORMATIONAL VALUE OF WHOLESALERS
AS AN INTERFACE BETWEEN PRODUCERS AND CONSUMERS

(A) No Middleperson or Wholesaler 5X6=30 Contacts Necessary



(B) One Middleperson or Wholesaler 5+6=11 Contacts Necessary



Source : ADAPTED FROM BEN M. ENIS, Marketing Principles: The Management Process, (Pacific Palisades, Calif; Goodyear Publishing Company Inc., 1974) p. 89.

Technological Information Exchange: Several information retrieval firms exist, such as IFI Plenum and Stanford Research Institute, with extensive computer data bases and world-wide information networks in many different areas of technology. These firms provide state of the art information in given technology areas and can be a source of new product ideas. In the Federal Supply Service PRIM System, there is some provision for interchange of technological information by the sponsoring of conferences and seminars in product areas.

Other sources of new product ideas are analyzing competitors' offerings, advertising agencies and new product development firms. These are not covered in the Federal Supply Service PRIM System.

This process is intended to generate as many new product ideas as possible. There is a high mortality rate for these ideas at each stage of the development process. Exhibit 6 shows that only one of 58 new product ideas survives the process and becomes a commercial success (Booz, Allen, Hamilton, 1968; Connor, 1964). Therefore, the first objective of the Federal Supply Service PRIM System is to work with interested business firms to develop the maximum number of feasible new product ideas. This is accomplished by the PRIM suggestion subsystem.

The PRIM Suggestion Subsystem

The PRIM Suggestion Subsystem is designed to:

1. Identify products which would be promising candidates for successful development using the PRIM System.

2. Solicit ideas for product improvement and the development of new products involving new technology and technology transfer by capturing procurement data which indicates the need for improved or new products.

3. Review and analyze suggestions for new and improved products to insure that all facts are available and considered.

4. Select product ideas having a high probability of involving technology transfer or using new technology which would benefit the government and the non-government markets.

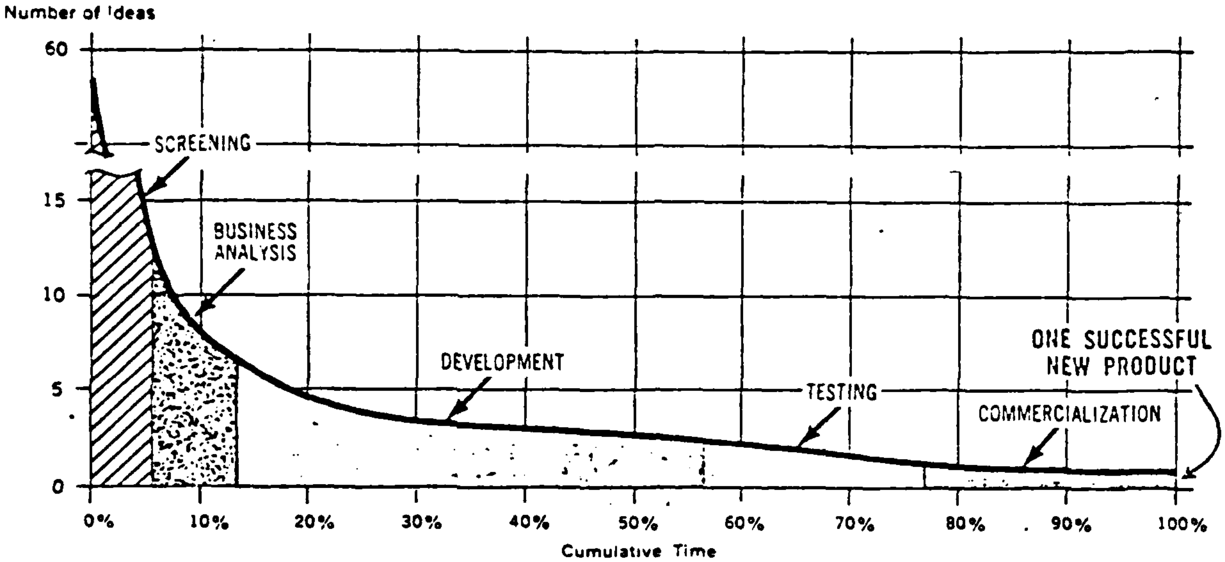
Exhibit 7 presents the conceptual design of the PRIM Suggestion Subsystem. Each part is fully developed conceptually and operationally in the GSA-Federal Supply Service PRIM Handbook. The preliminary test of the Suggestion Subsystem has shown the need for some smoothing, but it did operate satisfactorily.

The functions performed by various units or sectors of the Suggestion Subsystem are outlined below.

The Management Module comprises a management board of senior level Federal Supply Service managers which coordinates the operations of the other parts of the subsystem. The Board's function is to ensure that product improvement suggestions are:

EXHIBIT 6

MORTALITY RATE OF NEW PRODUCT IDEAS



Source: MANAGEMENT OF NEW PRODUCTS, 4th ed.
(New York: Booz, Allen and Hamilton, Inc., 1968) p. 9.

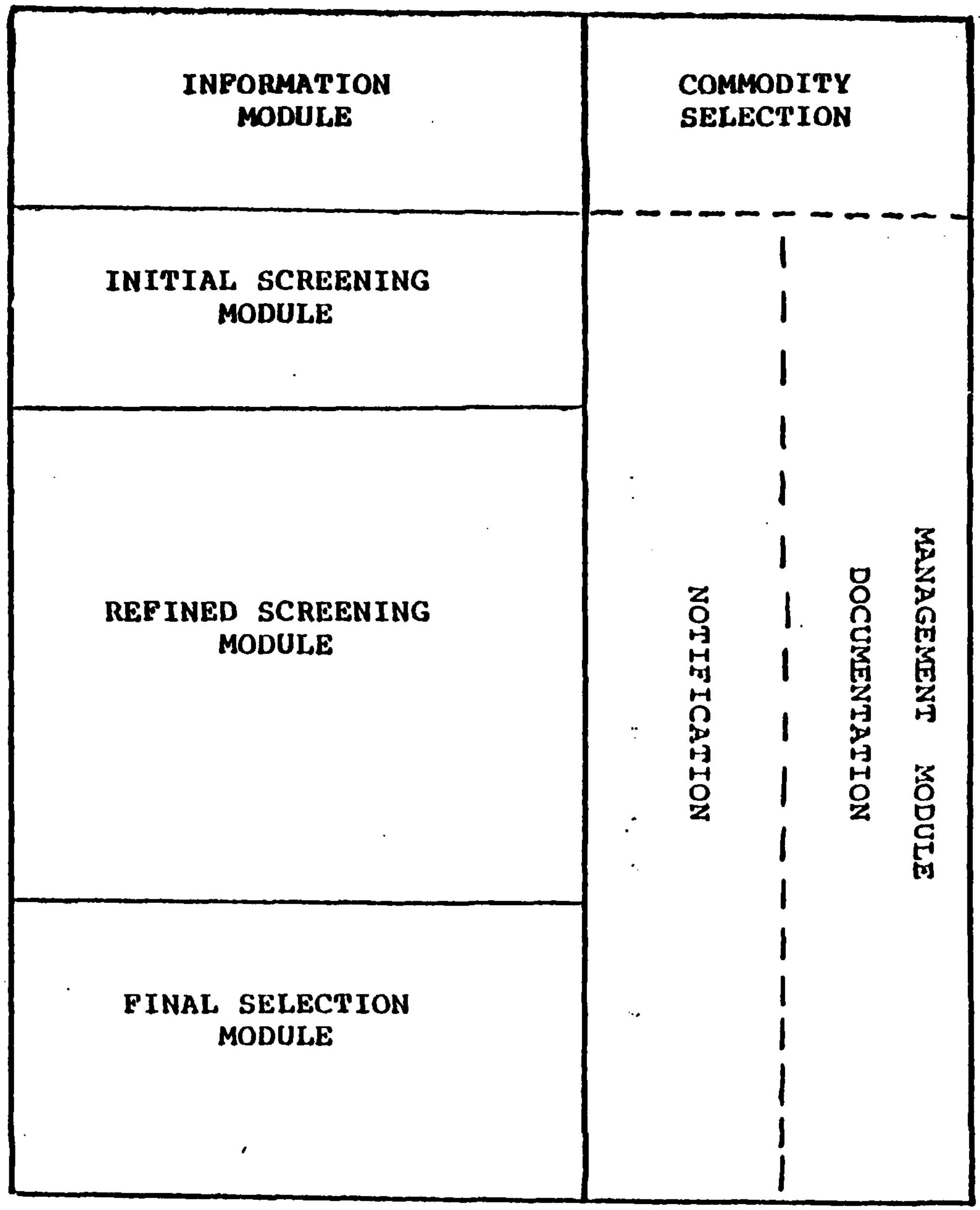
RATE OF COMMERCIAL SUCCESS

	New Product Idea	Product Development Projects	New Products Introduced
	SUCCESS PERCENTAGES		
All Industry Groups	1.7 %	14.5 %	62.5%
Chemical	2.0 %	18.0 %	59.0 %
Consumer Packaged Goods	2.0 %	11.0 %	63.0 %
Electrical Machinery	1.0 %	13.0 %	63.0 %
Metal Fabrics	3.0 %	11.0 %	71.0 %
Non-Electrical Machinery	2.0%	21.0 %	59.0 %
Raw Materials Processors	5.0%	14.0 %	59.0 %

SOURCE: MANAGEMENT OF NEW PRODUCTS 4th Ed., (New York: Booz, Allen and Hamilton, Inc., 1968) p. 12.

9

EXHIBIT 7
SUGGESTION SUBSYSTEM
The Federal Supply Service PRIM System



- Solicited for the products selected by the board;

- Processed in a timely manner;

- Documented and recorded properly;

- Reported back as to status to the suggesters; and

- Reported as to progress through the system to the board.

Perhaps the two crucial aspects of the Suggestion Subsystem are: selection of the commodity category for improvement suggestions and solicitations of new product improvement ideas.

The Commodity Selection decision is made by the Commissioner and the Assistant Commissioners of the Federal Supply Service, based on a rank-ordered list provided to them. The commodity must be one of the common-use product classes that Federal Supply currently supplies, or could supply, to its customer-government agencies. PRIM Product Idea Kits are distributed to the appropriate senior-level executives to provide them with background information and facts to assist them in the decision process.

Ideas are also solicited from procurement officers in customer-federal agencies and from ultimate users of the product. A list of these ultimate users is obtained from manufacturers, trade associations, retailers and wholesalers.

PRIM Product Idea Kits are made available to each of these sources for ideas to encourage participation and to make it easy to contribute ideas to the program. Persons or firms sending in ideas must complete a standard disclaimer on the Product Improvement Idea Collection Form included in the kit, to avoid possible lawsuits. All submitted ideas are acknowledged and the person making the suggestion is kept informed of the status of his suggestion, i.e., whether it is under consideration, has been rejected, is really a product quality complaint rather than a product improvement suggestion, or has been accepted for testing. While there is no sure way of knowing, it is anticipated that fewer than five percent of the suggestions will survive screening to become product experiments.

The Information Module provides a systematic method of identifying, contacting and actively soliciting potential sources for product improvement ideas. These sources will be both within the Federal Supply Service, and from outside, including other government agencies, manufacturers, wholesalers, retailers, and trade associations. The list will include universities, research groups, state governments, inventors, new product consultants, scientific and technological experts, venture capitalists, and patent attorneys as well as the general public. Other possibilities include advertising in such publications as the Commerce Business Daily and obtaining publicity on radio and television and in the print media.

Initial Screening of a product idea submission will be performed by clerical personnel. Ideas will be rejected and returned to the sender if:

- the standard disclaimer has not been signed and submitted;
- the form outlining the idea is so incomplete that it cannot be processed;
- the idea is impractical, has only novelty value, or is basically a quality complaint about current Federal Supply offerings;
- the product is outside the scope of Federal Supply. Examples would be weapons systems or platforms, military gear, space technology or ocean-technology items, etc.

A form with yes/no type questions is used to perform this initial screening as shown in Exhibit 8.

Refined Screening takes into account the criteria shown in Exhibit 9 before the idea is passed to senior-level management for final commodity selection:

a. Federal Supply Service market aspects;

b. product considerations;

c. financial considerations;

d. Contribution to or impact on the President's and Congress' National Goals;

e. external market considerations (outside FSS);

f. Federal Supply Service's ability to implement the product (resources available);

g. Experimental Technology Incentive Program considerations.

Without going into detail, Exhibit 10 provides a general expansion of the detailed factors in each area that would be considered during refined screening. The screening committee's recommendations and findings will be funneled to the PRIM Management Board for final decision.

Exhibit 11 shows the proposed organization of the PRIM System. The key person keeping track of the system would be the PRIM manager, reporting to a PRIM Management Board. The Suggestion Subsystem, which has been discussed above, is shown and also the other subsystems which will now be discussed.

The Procurement Techniques Subsystem's basic purpose is to develop a list of available and appropriate procurement techniques and incentives for various purposes, and to actively solicit new procurement techniques and incentives combinations to add to the list. These solicitations would be both internal (within Federal Supply) and external including both other government agencies and other external sources.

Exhibit 8
The Federal Supply Service PRIM System
Suggestion Subsystem Preliminary Screening Checklist

1. Form Completeness:
   (a) Form filled out correctly? YES ☐ NO ☐
   (b) If no, must it be sent back to source? YES ☐ NO ☐

2. Suggestion Validity
   (a) Is suggestion a novelty item? YES ☐ NO ☐
   (b) Is suggestion a complaint? YES ☐ NO ☐

3. Type of Suggestion
   (a) Does it involve a new product? YES ☐ NO ☐
   (b) Does it involve a technological innovation in a current product? YES ☐ NO ☐

4. FSS-Market Size and Potential Demand
   (a) Does FSS currently purchase product? YES ☐ NO ☐
   (b) Is there a demand for product by Government? YES ☐ NO ☐
   (c) Is the volume of demand over $100,000? YES ☐ NO ☐

5. Market Potential Need
   (a) Is there potential demand for it in FSS? YES ☐ NO ☐
   (b) Is there potential demand for it in Government? YES ☐ NO ☐
   (c) Is the market for it expanding? YES ☐ NO ☐

6. ETIP Objectives - Use in Private Sector
   (a) Does it affect technological innovation of a currently commercially available product in the private sector? YES ☐ NO ☐
   (b) If no, does it have a high potential for commercial application? YES ☐ NO ☐

7. Financial Impact
   (a) Is there a high probability of reduced unit cost? YES ☐ NO ☐
   (b) Is there a high probability of reduced cost over the life of the product? YES ☐ NO ☐

8. Legal Impact
   (a) Is there a patent pending on the product improvement? YES ☐ NO ☐

EXHIBIT 9

The Federal Supply Service PRIM System

SUGGESTION SUBSYSTEM — FINAL SELECTION CHECKLIST

I. The Commodity Selection Criteria and Applicability of the Idea to FSS Needs.

- Potential for FSS expansion into existing federal market.
- Size of national market and percent of FSS share (also percent of federal share).
- Potential for cost savings (i.e., high probability of technological transfer or development).
- Major demonstrated need for improved service (i.e., waivers, complaints, open market procurements).
- Ease of establishing dialogue with related industry (i.e., existence of representative trade association, current FSS relationships with industry).
- Potential for effecting change through procurement incentives or removal of disincentives (negotiated vs. competitive procurement).
- Relationship to national priorities and federal trade and safety regulations.

II. FSS Organizational and Legal Considerations.

- Is FSS market large enough to warrant experiments?
- Can FSS implement the idea?
- Does the idea require the cooperation or lead of other agencies?
- Are incentives available?

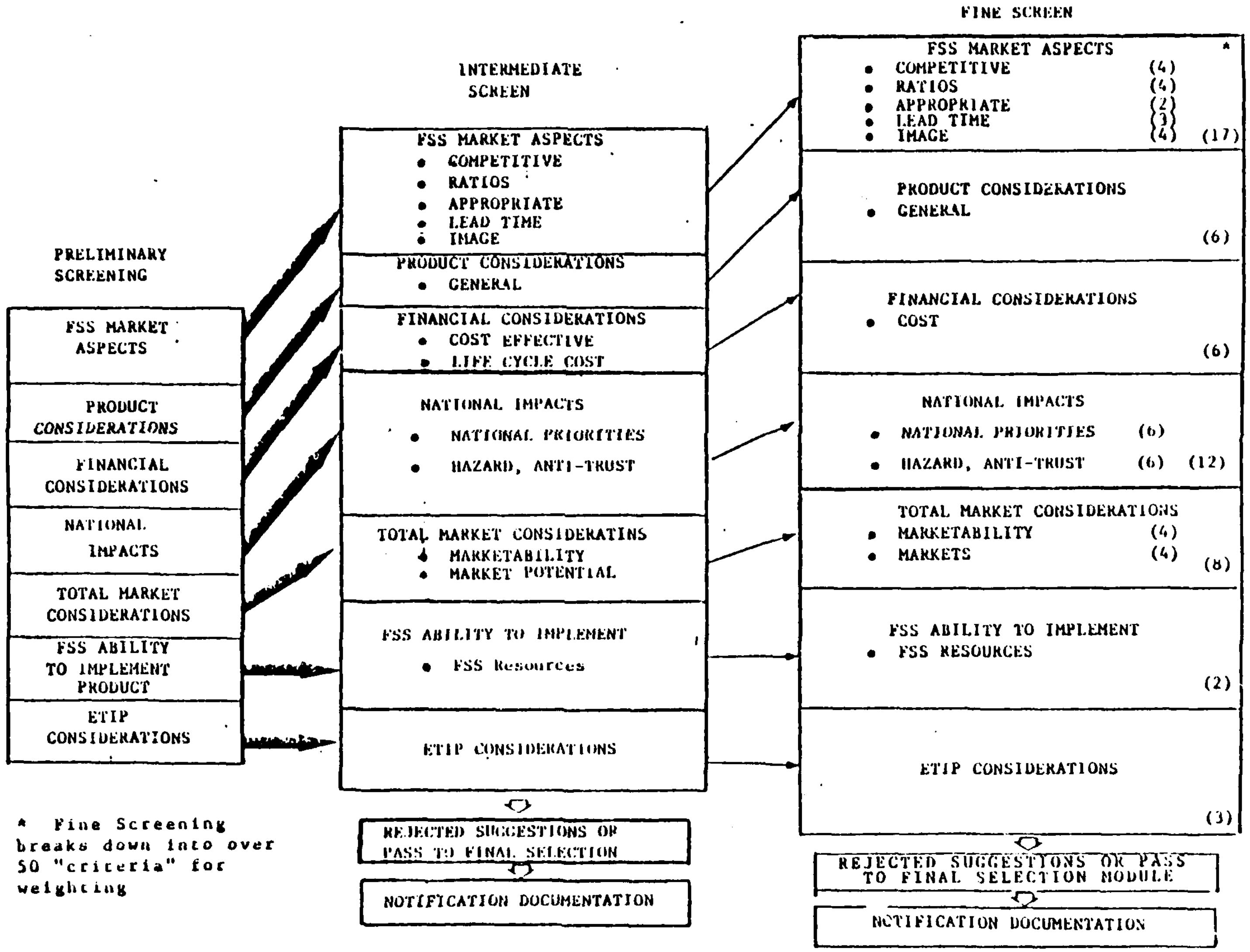
III. ETIP Considerations.

- Degree of product technology.
- Potential for technological innovation.
- Potential for technological transfer.

EXHIBIT 10

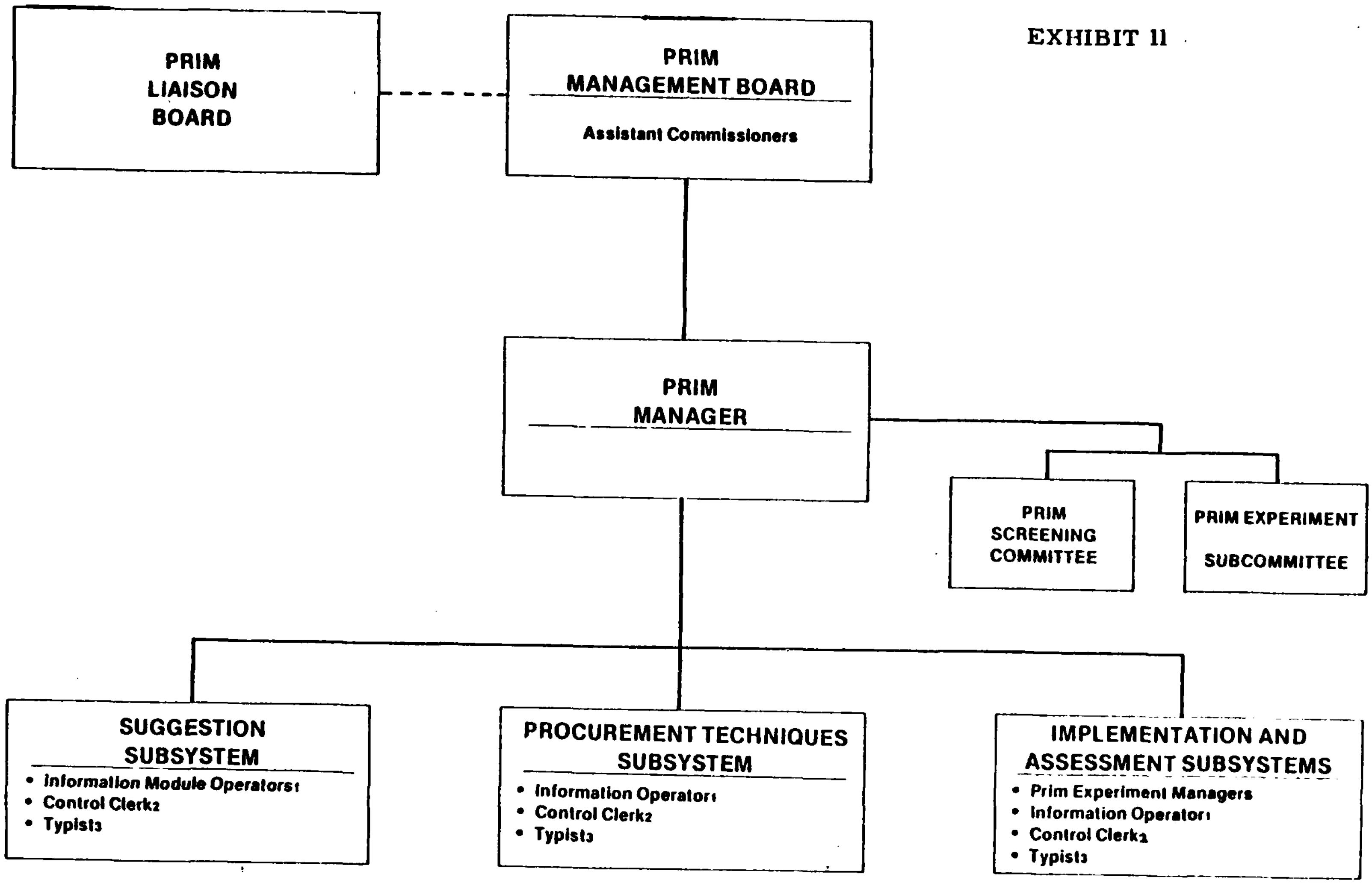
Expansion of Refined Screening

The Federal Supply Service PRIM System



* Fine Screening breaks down into over 50 "criteria" for weighting

EXHIBIT 11



NOTES:

[1]The Information Module Operator for the suggestion subsystem will also support the requirements of the other subsystems.

[2]The suggestions subsystem control clerk will also support the requirements of the other subsystems as required.

[3]The typist will perform administrative support for all subsystems.

ORGANIZATION FOR PRIM SYSTEM OPERATION. . .

The Procurement Techniques Subsystem is both modular and integrated -- modular to permit ease and simplicity of operation, and integrated so that each module works in conjunction with the others to facilitate the solicitation and evaluation of procurement techniques and incentives for stimulating product improvements.

Exhibit 12 shows the Procurement Techniques Subsystem and its three modules or units. The subsystem is based on an Operating Handbook developed by the contractors, to assist Federal Supply to:

- Identify procurement techniques or incentives which would be likely to encourage successful improvement intervention.

- Select those available and appropriate procurement techniques and incentives that are most likely to have a high chance of achieving product improvement or new technology.

The basic purpose of the Management Module of the Procurement Techniques Subsystem is to provide a systematic process for evaluating, controlling and updating the GSA Handbook for this subsystem.

The Procurement Technique Subsystem Information Module performs the following functions:

- Identifies potential sources of ideas for procurement techniques and incentives from both internal and external sources.

- Defines the content and form of the information collection instrument.

- Develops a practical, approved procedure for contacting sources.

The Information Module is basically concerned with gathering ideas and suggestions for new and improved procurement techniques and incentives to encourage new product improvements and new technology.

This done in three ways: First, by a mail questionnaire or survey; second, by personal structured interviews; and third, by review of the new literature in the field, as it becomes available.

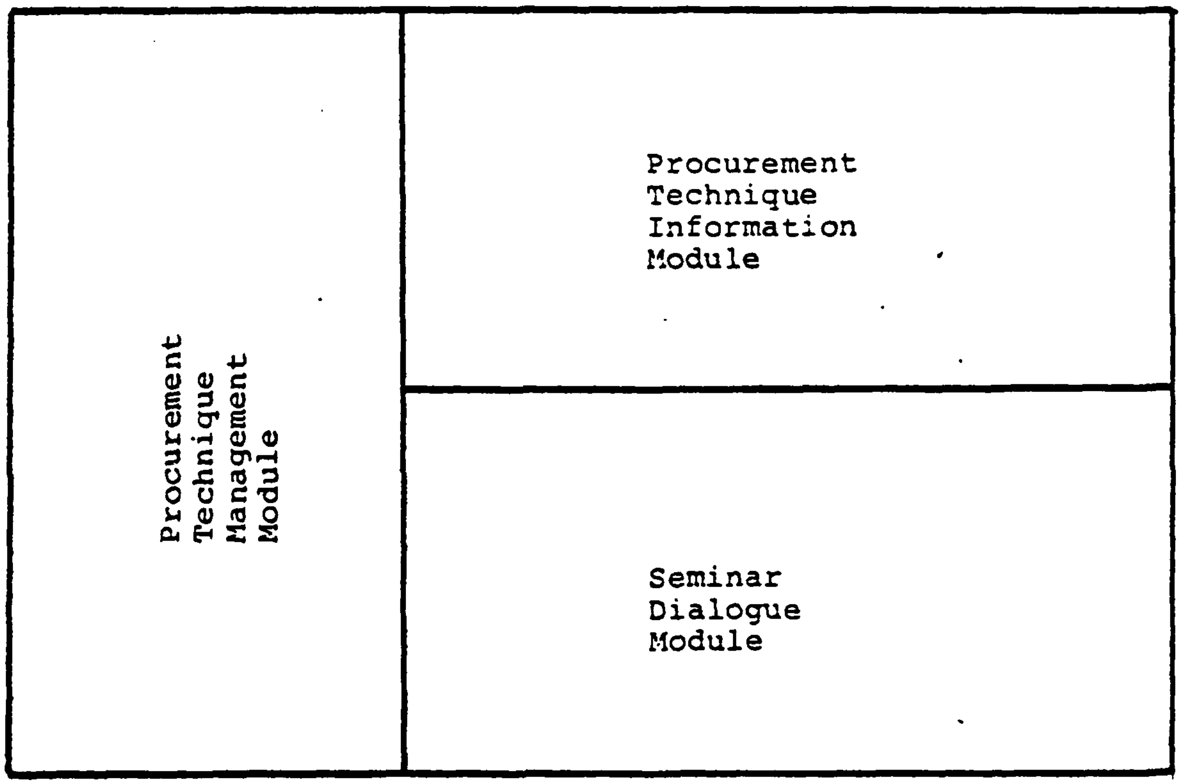
The Procurement Techniques Subsystem Seminar Dialogue Module is intended to provide a means for direct interface, dialogue, and feedback between the Federal Supply PRIM System and the private sector organizations that are likely to be most interested in product improvements, new products, innovations, technology transfer and new technology.

The basic purpose of the seminars is to identify currently existing incentives and disincentives which encourage or discourage private sector firms from contracting with the federal government. The seminars rate a separate module both because of their importance to the PRIM System and to the complexity involved in planning and carrying out the seminar program.

The seminars are designed to accomplish the following:

EXHIBIT 12

PROCUREMENT TECHNIQUES SUBSYSTEM
The Federal Supply Service PRIM System



- Elicit from industry personnel their awareness, understanding and concerns regarding Federal Supply Service procurement techniques, practices, and policies. The dialogue should stimulate industry to suggest how current procurement practices and policies could be modified to enhance new product development.

- Provide Federal Supply officials with the opportunity to listen to the concerns of industry and to plan appropriate action for future procurement, particularly with the objective of obtaining new and improved products.

- Open discussion and lines of communication between Federal Supply and industry on areas of potential modification and improvement in Federal Supply's procurement practices.

The Federal Supply Service PRIM System has specific management objectives in mind in sponsoring these Seminar Dialogues. These can be defined as follows:

1. Determine what procurement techniques can affect new product development and/or encourage technology transfer, which can be adopted by Federal Supply.

2. Identify procurement disincentives which hinder the development of new products, which can be targeted for removal or, at least, minimization.

3. Develop industry knowledge and interest in the Federal Supply Service PRIM System and its PRIM experiments.

4. Ascertain what conditions are necessary to enlist industry cooperation with Federal Supply on PRIM experiments.

5. Evoke "soft" incentives (i.e., non-monetary) that would be viewed positively by industry in terms of new product development, product improvements, and technology transfer.

6. Increase industry awareness of currently available incentives to produce new products and to encourage technology transfer from government sources to the commercial market.

Booz-Allen Applied Research (1973) has developed a schematic representation of the general Federal Procurement Process (Exhibit 13).

The process can be reduced to eight major stages, as follows:

1. Establishment and definition of requirements.

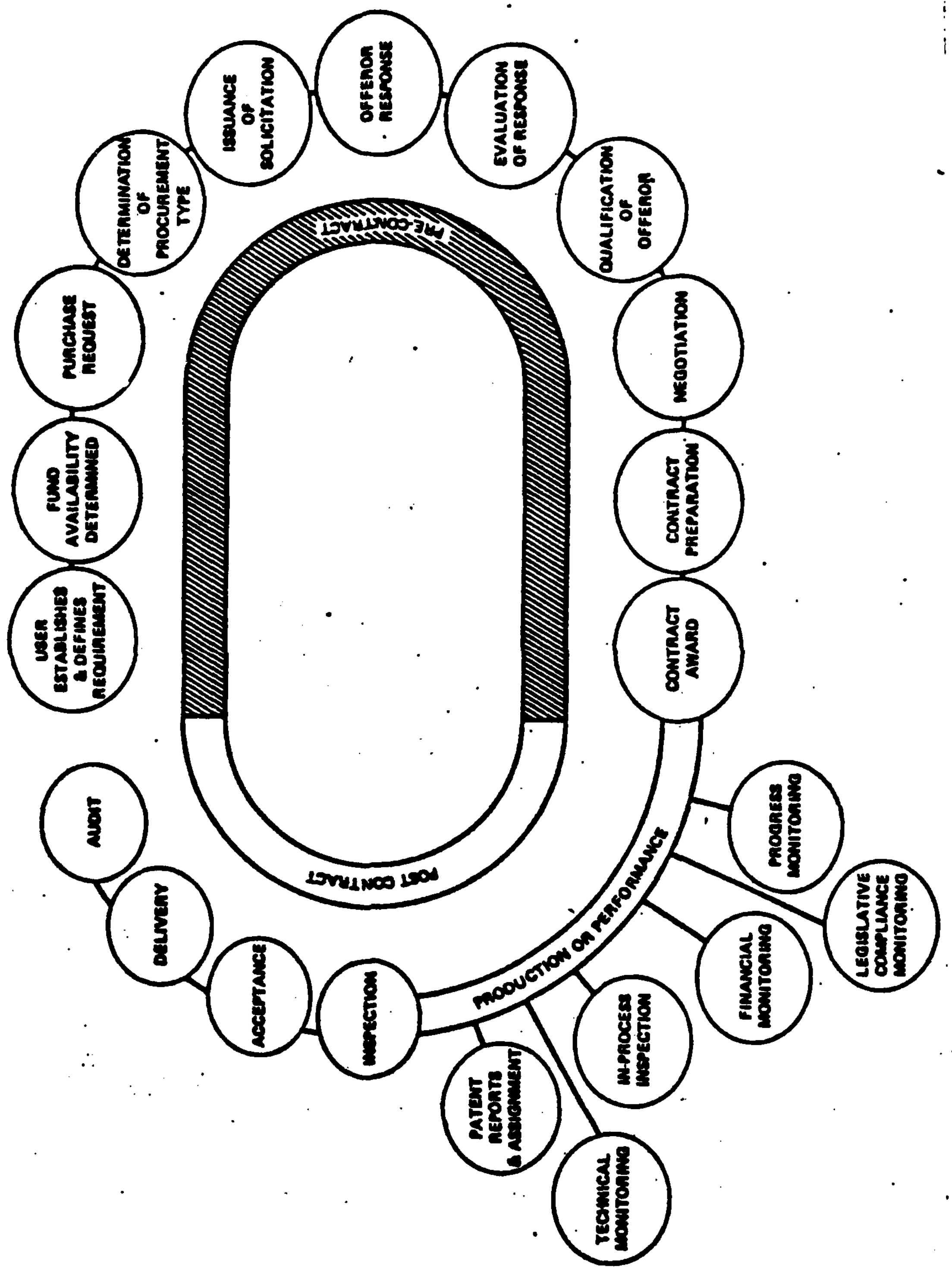
2. Determination of fund availability.

3. Purchase request.

4. Selection of procurement method and development of solicitation for issuance.

EXHIBIT 13

The General Federal Procurement Process



Booz-Allen Applied Research. Government Procurement As An Incentive To Commercial Technology and Innovation. (COM-73-11375) March 1973.

5. Offeror response and evaluation.

6. Qualification of offeror.

7. Negotiation, contract preparation, and award.

8. Production or performance monitoring.

The Federal Supply Service PRIM System assumes that each of these stages of the federal procurement process presents an opportunity for intervention to encourage new product development, product improvement, or technology transfer. Let us briefly consider the opportunity in each stage.

Stage I. Establishing the need and defining requirements. The degree of flexibility in this stage directly relates to the amount of innovation or technological change possible under the contract. If increased flexibility is allowed under the contract requirements, the contractors will have more room to review and evaluate the project functions and to develop new products and innovative approaches. Limited flexibility in this stage inhibits change and innovation by the prospective vendor or contractor.

Stage 2. Determination of Funds Availability. The modus operandi of government procurement has been to award contracts to the lowest bidder. Innovation, new product development, improving products, and new technology all cost money. Unless there is a reward or incentive to do a better job, few contractors will be interested in doing anything other than in bidding in with the lowest quality, least-costly-to-produce product that will meet, but just barely meet, specifications. It is difficult in conducting the public's business to justify the costs of innovative products when standard products will meet the functional need. However, the PRIM System suggests that each agency should set priorities on its objectives to determine the funds available for each need. This dictates how much can be allocated for innovative approaches. Thus, additional flexibility in this area of funds availability will provide a basis for offering incentives for product improvements.

Stage 3. The Purchase Request Defines the Requirements to be Filled by the Project or Product. The characteristics or performance levels which satisfy the requirements to be filled really define the product required. The purchase request, through solicitation, should communicate to the prospective contractor or vendor the exact details of what is required. The five minimum elements of the purchase request are: (1) adequate description of the characteristics or performance required; (2) measurement criteria for determining these characteristics or performance levels; (3) standards of unacceptable, acceptable and superior characteristics and performance; (4) cost levels considered unacceptable, acceptable and superior, and (5) performance levels desired. Again, the more flexibility permitted the prospective contractor or vendor within these "ground rules" the more likely innovation, technology transfer, new products, and product improvements are likely to occur.

Stage 4. Selection of Procurement Method and Development of Solicitation. While the methods of procurement, whether by formal advertising or negotiation, are strictly regulated, some general conclusions, derived from the literature can be drawn.

In general, negotiated procurement is more conducive to technological innovation because it allows greater flexibility, through the use of performance specifications. This obviously is preferable to a detailed and exact statement of product particulars, prescribing materials, dimensions, packaging, and workmanship of something to be built, installed or manufactured. Exact written product descriptions may help the procurement officer obtain low-priced (and frequently low-quality) products and thus stretch budget-dollars, but it does nothing to encourage and, in fact, tends to discourage innovation, new technology and technology transfer. Thus, the federal government -- the largest single customer for most goods and services in the United States -- in its zeal to economize the taxpayers' dollars, tends to be a barrier to economic growth, innovation, and technological development. Yet this is the exact opposite of the country's National Goals in these areas, and in the long run, does the national economy, the private sector and our citizens a disservice.

Stage 5. Evaluation of Offeror Response Provides the Method to Select the Appropriate Firm for the Contract Award. This stage provides the most innovative ideas and technologies for consideration by the contracting agency. Allowed variances in certain areas, such as design, performance, and cost, encourage contractors to develop innovative approaches to the problem or need. It is specially important that in considering these proposals, the responsible person should have an open mind to innovative ideas which could be of value to the government at present or in the future. To stimulate innovation, procurement personnel at all levels should take an extra look at proposals which offer technological change where such technological change might benefit the government. It should become accepted procedure in negotiated procurement (in those commodity areas selected by management) to choose the innovative proposal over the low bid proposal (within prescribed limits), where innovation can be related to price.

Stage 6. Qualification of the Offeror should involve a pre-award check on the contractor's track record on past innovative ideas. A contractor with a past record of successful innovations could be rated qualified to develop additional new products or ideas. In addition to past innovative performance, the pre-award check should rate the factors of financial responsibility, technical capability, and the backlog of work which could affect delivery potential.

Stage 7. Negotiation, Contract Preparation and Award should include incentives directed toward cost-effecitveness and innovation. These incentives can take a variety of forms, but it should be recognized that the contract can act as an incentive or disincentive to innovation. Fixed-price contracts encourage cost-effectiveness while cost-plus contracts allow the contractor more flexibility for innovation. The type of contract and incentive should be given careful consideration. Clauses, specifications and special provisions should be determined by management to match the project's goals with the types of incentives that will attain these goals. The PRIM System has a library of incentives matched to goals which have been developed to assist in this effort.

Stage 8. Performance Monitoring procedures under the usual government regulations act to inhibit contractor investment in product or cost improvement. Some agencies have found Value Incentive Clause (VIC) useful in encouraging contractors to originate cost-effective performance change. This clause allows contractors to alter a process, standard or final product through a Value Change Proposal (VCP). This process has facilitated contractor innovation; the PRIM System anticipates use of VIC/VCP in appropriate areas, to make change proposals less difficult and time consuming. To promote innovation at this stage of the procurement process, the government monitors should be aware of the importance of potential changes, even those at odds with the contractual terms, should be an integral part of the PRIM System to do their part in encouraging innovation and change by contractors. Another incentive to encourage innovation is the use of multiple incentive contracts. The example illustrated in Exhibit 14 (Farmer, 1968) shows that the fee or payment the contractor can expect to receive varies directly with final performance characteristics of the end-product. This approach combines both positive incentives for superior performance and penalties for substandard performance.

Legal Aspects and Types of Procurement Contracts

The development of the Federal Supply Service PRIM System required an intensive study of the legal aspects of the procurement process, involving both formal advertised procurement and negotiated procurement. These provisions are necessary to protect the taxpayer, the government, and the government employee. Needless to say, the PRIM System will operate within these provisions.

There are three major types of procurement contacts which can be used in the PRIM System. These are classified as follows:

- Fixed-price type contracts

  Cost-type contracts

- Special-type contracts

These types of contracts and their variations are familiar to all those who sell to the federal government as well as to contracting officers. Therefore, the types and the variations authorized by the Code of Federal Regulations are simply listed below:

A. Fixed-price type contracts

   1. Firm fixed-price contract

   2. Fixed-price contract with escalation

   3. Fixed-price incentive contract

   4. Prospective price redetermination at a stated time or times during performance.

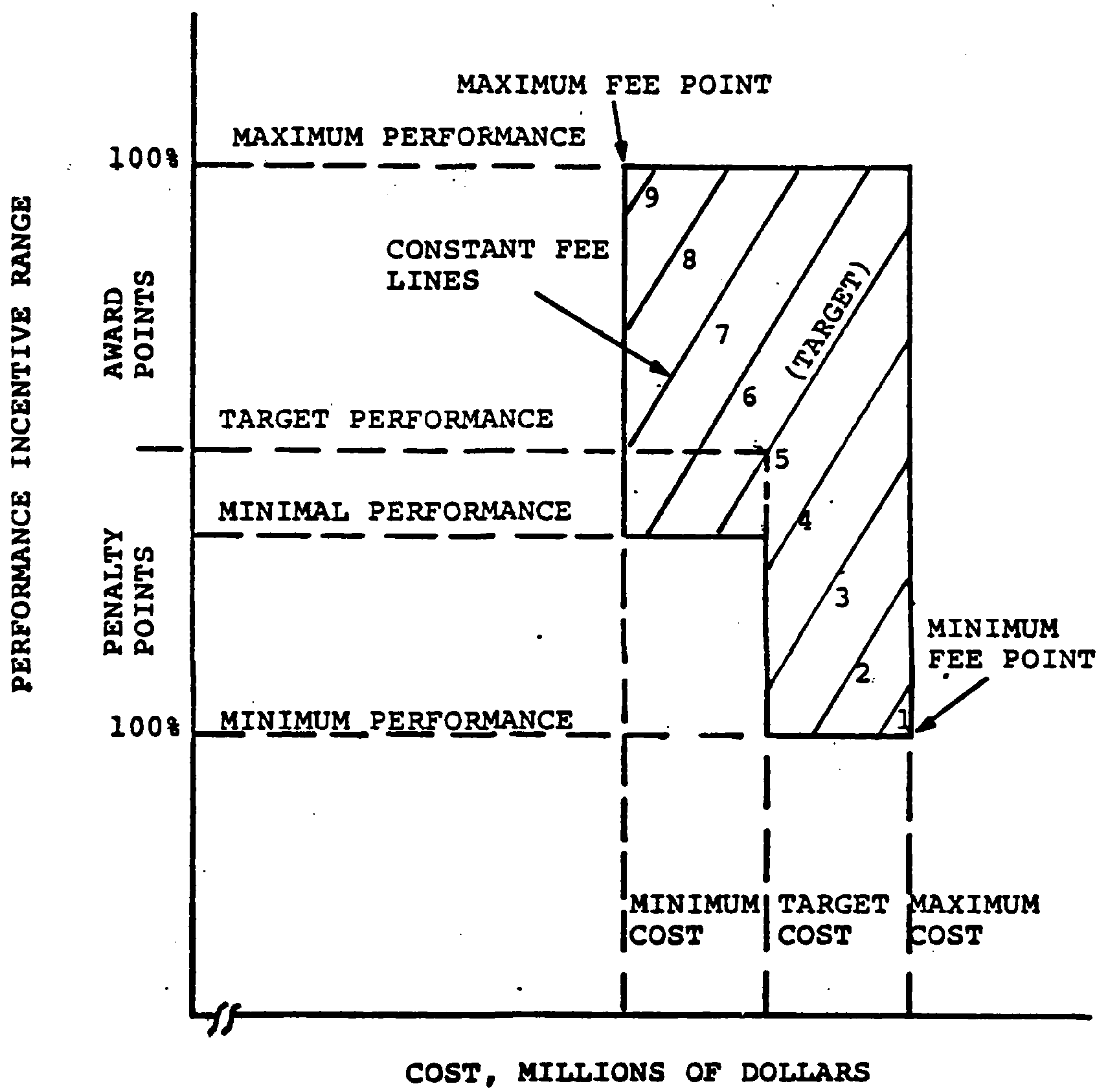
   5. Retroactive price redetermination after completion.

B. Cost-reimbursable contracts

   1. Cost (or cost-reimbursement) contract

EXHIBIT 14

Multiple Incentive Contract
Fee Achievement based on Performance
vs. Cost at Target Schedule



W. A. Farmer. "Multiple Incentive Contracts: An Analytical Technique," N.A.A. Management Accounting, Vol. 49 (May 1968), P. 19.

2. Cost-sharing contract

3. Cost-plus-incentive-fee contract

4. Cost-plus-a-fixed-fee contract

5. Cost-plus-award-fee contract

C. Special types of contracts

1. Time and materials contract

2. Labor-hour contract

3. Letter contract

4. Indefinite delivery type contract

5. Basic agreement

6. Basic ordering agreement

There are also a number of provisions related to contracting with small and minority businesses.

Each kind of contract may be useful as an incentive to innovation in particular cases or circumstances. The PRIM System is expected to work closely with procurement in the commodity areas selected by management so that the appropriate kinds of contracts are used as incentives to innovation.

Procurement Techniques as Incentives

A major purpose of the PRIM System study was to provide recommendations on existing and potential procurement techniques which could be used as incentives for innovation and technology transfer to private enterprise in developing new products.

After exhaustive study of the literature and personal interviews with key figures and experts in the field, the following items were developed:

A. Special contract provisions and clauses

1. Value Incentive Clause (VIC) invites industry to challenge unrealistic or unessential government contract requirements. The study indicates that contractors look favorably upon the VIC because it enables them to increase their profits by sharing in approved savings. (U.S. Army, 1966; General Services Administration, 1975a; 1975b;).

2. Value Management Program Requirement Clause (VMPRC) obligates the contractor to maintain value management efforts in accordance with an agreed program and provides for limited contractor sharing in cost reductions resulting from change proposals which the firm submits. (Department of Defense, 1969; U.S. Army, 1971).

3. Economic Price Adjustment Clause can be used in single or multi-year contracts to protect the contractor and/or the government when changes in prices of the factors of production are greater than anticipated, by allowing for price adjustment in the contract.

4. Patent Rights License Clause provides that the contractor retains title to the invention or innovation, provided it is patentable, but grants to the government an irrevocable and royalty-free license for use of the patented innovation.

5. Patent Rights Title Clause provides that the government retains title to any patentable invention or discovery conceived or first actually reduced to practice during the performance of a contract but that a non-exclusive, royalty-free license will be granted to the contractor. Since the prospective loss of a valuable patent title often dissuades contractors from entering into a relationship with the government, this clause is generally limited to contracts for items where the research and development costs are too high for industry to bear. This clause would probably not be used except in the case of minority or small businesses particularly considering the kinds of low-technology goods handled by Federal Supply.

6. Performance Specifications, instead of product design specifications, can be a very powerful tool to promote innovation. Performance specifications frequently provide maximum, minimum and target performance standards as guidelines for development and production. They can also be used to evaluate contractor performance as the basis for payment of an incentive fee. Performance specifications provide the contractor with an incentive to develop alternative methods of operation at a cost-saving, tied in with life cycle costing, or to aim for target or superior performance levels, to achieve an incentive fee award. (Lamb, 1974; Pirtie, 1975).

Other existing government procurement alternatives which can be used to promote innovation and technology transfer are:

A. Value Management (VM) is an organized effort directed at analyzing the functions of systems, equipment, facilities and supplies for the purpose of achieving the required function at the least overall cost, consistent with performance requirements. These requirements include reliability, maintainability, and delivery. Performance, however, cannot be compromised; it must remain equal to or exceed that called for in the contract. The incentives are the Value Incentive Clause (VIC) and Value Management Program Requirement Clause (VMPRC), covered previously. (U.S. Army, 1965, 1971; Dept. of Defense, 1964a, 1964b; General Services Administration, 1975).

B. Life Cycle Costing (LCC) considers the total cost of ownership when determining which item or system is most cost effective. In one model, total life-cycle costs represent the sum of initial acquisition cost, initial logistics costs, and recurring costs. In the absence of such a concept, government contracts are usually awarded on the basis of lowest acquisition costs, which may not be the lowest cost item with all costs considered, in the long run. Life Cycle Costing has not achieved its predicted success in governmental procurement operations. However, the concept probably merits continued applicability in encouraging innovation and new product development (Dover, 1974; Goldman, undated; Lang, 1970; Logistics Management Institute, 1967).

C. Design-to-Cost (DTC) is instituted during the design and development stages of a project. The basic principle behind design-to-cost is to set the cost and develop a design with an acceptable performance. The goal is to develop a cost-efficient and effective product. While difficult to administer for both the government and the contractor, design-to-cost -- particularly in combination with life cycle costing --may be a valuable incentive for innovation and new product development. (Dept. of Defense, 1965; Aerospace Industries Assn., 1974).

Each of these methods of procurement can be adapted as incentives for innovation, and will be considered in the PRIM System.

Implementation and Assessment Subsystem

The last two parts of the Federal Supply Service PRIM System are the Implementation and Assessment Subsystems. Both relate to task three of the contract to develop the PRIM System:

> Develop a means for implementing product improvement suggestions and technology transfer and for assessing the impact that federal procurement techniques and incentives have on the non-government marketplace.

Exhibit 15 illustrates these two subsystems conceptually.

The most interesting segment is the Implementation Subsystem which visualizes conducting marketing experiments with the commodities selected by the Management Board from those ideas surfaced by the Suggestion Subsystem.

The Experiment Selection Module is the discriminator which determines and extracts the product with the best opportunities for innovation and for testing specific procurement techniques and incentives selected as important by the PRIM System Management Board. The product selected will be measured against three criteria:

- Meeting the basic Federal Supply Service objectives of fostering new products and product improvements which will better serve customer-government agencies.

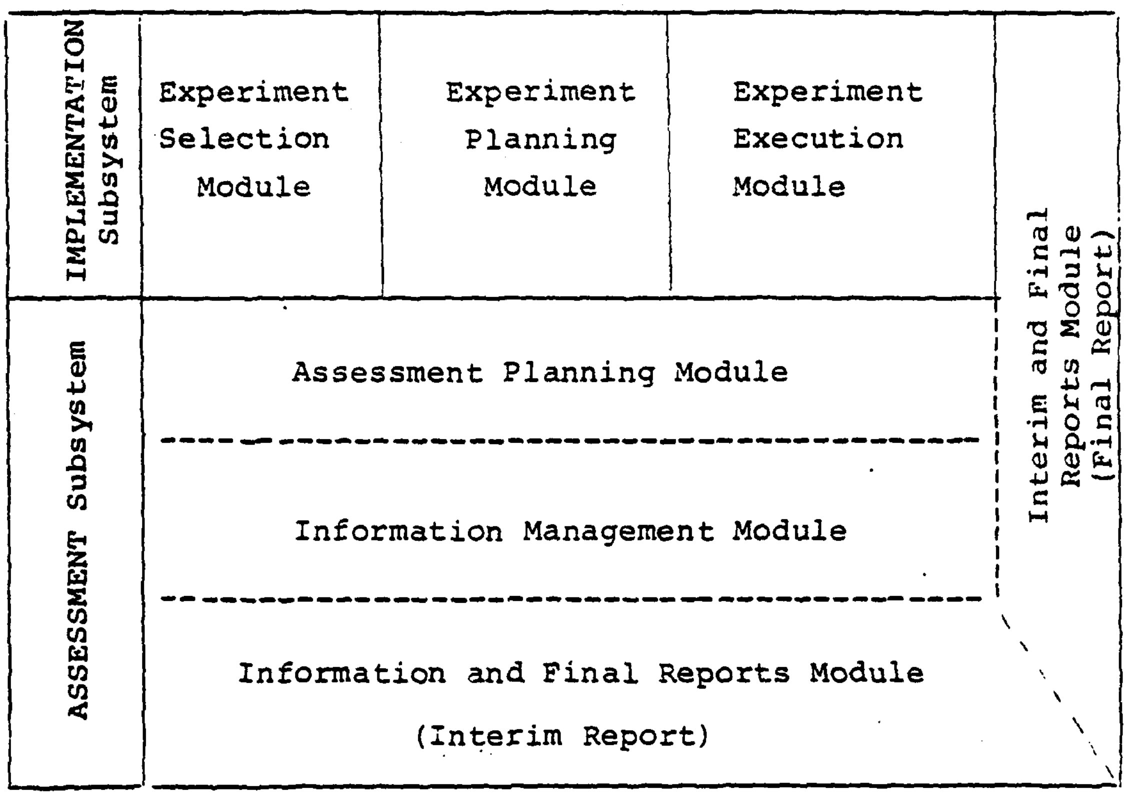
- Develop answers to questions about the effectiveness of incentives and procurement techniques, as well as the PRIM System as a whole, in promoting innovation, technology transfer, new products and product improvements.

- Stimulate and encourage industry support and cooperation in achieving Federal Supply Service objectives and in later successfully marketing the improved or new products commercially.

Once the product is selected for the experiment, the PRIM System Experiment Planning Module becomes operational and develops the experiment objectives and the experiment plan. The PRIM System Management Board sets the experiment objectives for each procurement. These objectives should serve the Federal Supply Service's long and short term goals and also should be relevant to and up-to-date with the current market atmosphere in the product industry.

EXHIBIT 15

IMPLEMENTATION AND ASSESSMENT SUBSYSTEMS



To assure the highest possible probability of success of the experiment the plan assesses the market and reviews the qualitative considerations before selecting the best strategies. A procedure is provided in the PRIM System to generate alternative strategies. The strategy selected for each product will attempt to achieve one or a combination of Federal Supply Service (FSS) goals for the program as defined below:

1. Assist the Federal Supply Service in achieving its five-year goals through improved procurement policies and practices.

2. Assist the Federal Supply Service in achieving a greater value for its purchasing dollar.

3. Test the efficiency of a number of procurement techniques and incentives in different situations to provide a basis for proposed changes in procurement policy.

4. Effect the transfer of technology between industries or marketplaces to improve the quality of products available to the consumer as well as the government.

5. Assist the government in reaching certain national goals through improvements in goods and services available to the government and the consumer.

Once the experiment plan has been developed and executed through a procurement officer, the final task is assigned to the Assessment Subsystem. This consists of developing an assessment plan, concurrently with the experiment plan, and then gathering and analyzing data and presenting interim and final reports to the PRIM System Management Board.

The Interim Reports will be presented periodically to the PRIM System Management Board as the experiment progresses for purposes of centralized experiment monitoring and control. The reports will follow this outline:

I. Executive Summary

   A. Background

   B. Significant Events

   C. Future Activities

II. Background

   A. Product Selection

   B. Experiment Objective

   C. Allocated Resources

   D. Description of Product Industry and Market

III. Current Experiment Status

A. Product Specification

B. Contractor Selection

C. Results of Preliminary Procurement Activity

D. Results of Procurement

E. Product

F. Contractor

G. Sales

IV. Future Activity

A. Next Quarter

B. Following Quarter

The Final Report on a PRIM System Experiment will evaluate the outcome of an experimental procurement and will comprise the following sectors:

I. Executive Summary

II. Review of Product and Experiment Selection

III. Purpose and Objectives of Experiment

IV. Review of Operating Plan

V. Review of Contractor Performance

VI. Resources Used

VII. Results

VIII. Conclusions

IX. Recommendation

<u>Current Status of the Federal Supply Service PRIM System</u>

While this paper has discussed the PRIM System as if it were already in operation, this is not the case. The system has been pilot-tested and seems to work quite adequately. It does seem a bit involved but this may be due to the fact that the system is so new and has not yet "settled in."

The PRIM System report is being studied for implementation. There are problems of staffing a new function, particularly during this period of austere budgets. There is also the question of whether this is an area that is appropriate for cooperation between government and industry. It would appear so, although perhaps a pilot-test of the system for a period of two or three years will be required before a final judgement can be made.

REFERENCES

Aerospace Industries Association of America, 1974. A Return to Basics: Implementing Design to Cost. Washington, D.C.

Barnett, H. G., 1953. Innovation: The Basis of Cultural Change. New York: McGraw Hill, p.7, cited in Robertson, 1967

Booz, Allen and Hamilton, 1968. Management of New Products p. 9.

Booz, Allen Applied Research, 1973 (March). Government Procurement as an Incentive to Commercial Technology and Innovation (Com-73-11375)

Buskirk, Richard, 1975. Principles of Marketing, 4th edition. Hinsdale, Illionis: Dryden Press. p. 240

Buttner, F. H., 1968. "An Integrated Model of Technological Change," in James F. Bright, editor, Technological Forecasting for Industry and Government. New York: Prentice Hall. pp 183-197.

Chakrabati, Alok K., 1973. " The Effects of Techno-Economic and Organizational Factors on the Adoption of NASA - Innovations by Commercial Firms in the U. S." Academy of Management Proceedings, 33rd Annual Meeting. pp.469, 471-473.

Conner, J. T., 1964. "Needed: New Economics for a New Era. Printer's Ink 287:35-37

Crawford, C. Merle, 1972. "Strategies for New Product Development". Business Horizons, 15:6:49-58

Department of Defense, 1964a. Fringe Effects of Value Engineering. Washington, D.C.

_______, 1964b. Principles and Applications of Value Engineering. Washington, D.C.

_______, 1965. Design-To-Cost Handbook. Washington, D.C.

Dover, Lawrence E., et al, 1974. A Summary and Analysis of Selected Life Cycle Costing Techniques and Models. Wright-Patterson AFB, Ohio: Air Force Institute of Technology

Drucker, Peter F., 1974. Management: Tasks, Responsibilities, Practices. New York: Harper & Row. p.61

Enis, Ben M., 1974. Marketing Principles: The Management Process. Pacific Palisades, California: Goodyear Publishing Co. p.89

Farmer, W. A., 1968. "Multiple Incentive Contracts: An Analytical Technique," N.A.A. Management Accounting, 49:9:18-24 at p.19

Foster, Richard N., 1971. "Organize for Technology Transfer." Harvard Business Review 49:6:110-119.

General Services Administration, 1975. Value Engineering, GSA-PBSP 8000.1. Washington, D.C.

_______, 1976. Product Improvement Intervention (PRIM) System Handbooks, Vols. 1 and 2. Developed for the Federal Supply Service by Organization Resources and Systems Advisors. Washington, D.C.

Goldman, A. S., undated. Problems in Life Cycle Support Cost Estimation. Schenectady, New York: General Electric Co.

Johnson, Samuel C., and Conrad Jones, 1957. "How to Organize for New Products," Harvard Business Review, 35:3: 49-62 at p.51, cited in Crawford, 1972.

Kotler, Philip, 1972. Marketing Management: Analysis, Planning and Control, Englewood Cliffs, N.J.: Prentice Hall. p.505

_______, and G. Zaltman, 1971. "Social Marketing: An Approach to Planned Social Change." Journal of Marketing 35:3-12

Lamb, William C., 1974. The Effect of the Design to Cost Concept on Required Operational Capability Documents. Maxwell AFB, Alabama: Air Command and Staff College.

Lange, Gunther, 1970. Life Cycle Costing; Problems, Policies and Prospects. Fort Lee, Virginia: U. S. Army Procurement Research Office

Logistics Management Institute, 1967. Life Cycle Costing in Equipment Procurement. Washington, D.C.

Normannn, Richard, 1971. "Organizational Innovativeness: Product Variation and Reorientation." Administrative Science Quarterly 16: 2:203-215 at p.204

Pirtie, Paul E., 1975. The Objective Functional Approach to Structuring Contractual Performance Incentives. Fort Belvoir, Virginia: Defense Systems Management School

PRIM System: Product Improvement Intervention System, 1976. GSA Handbook, Vols. 1 & 2, developed for the Federal Supply Service by Organization Resources and Systems Advisors, Inc., Washington, D.C.

_______, 1971. Communication of Innovation: A Cross - Cultural Approach. 2nd Edition. New York: The Free Press

_______, 1975. "Where we are in Understanding Innovation." Paper presented at East-West Communication Institute Conference on Communication and Change: Ten Years After. Honolulu.

_______, 1976. "New Product Adoption and Diffusion, Journal of Consumer Research 2:4:290-301

Ryan, B., and N.C. Gross, 1943. "The Diffusion of Hybrid Seed Corn in Two Iowa Communities," Rural Sociology 8:15-24

Trippi, Robert, and Duane R Wilson, 1974. "Techno-Transfer and the Innovative Process in Small Entrepreneurial Oganizations." Journal of Economics and Business. 27:1:64-68 at pp.64-66.

Uman, David B., 1969. New Product Programs: Their Planning and Control. New York: American Management Association. p.63

U. S. Army, 1965. Value Engineering Symposium: Advancement in the State of the Art. Redstone Arsenal, Alabama: U. S. Army Missile Command.

_______, 1966. Economic Impact of Value Engineering Changes. Alexandria, Virginia: U. S. Army Command

_______, 1971. Value Engineering Program Requirements Clause. Alexandria, Virginia: U. S. Army Material Development and Readiness Command.

Wasson, Chester R., 1974. Dynamic Competitive Strategy and Product Life Cycles. St. Charles, Illinois: Challenge Press

A QUANTITATIVE METHODOLOGY
FOR EVALUATING RELIABILITY IMPROVEMENT
WARRANTY OPTIONS

by
Captain Robert S. Tripp*
Management Sciences Office, HQ Air Force Logistics Command
and Dr. Robert J. Lucas
Metropolitan State College

INTRODUCTION

Prior to 1965, the use of warranties in Air Force contracts was generally limited to providing protection against latent defects or fraud discovered after government acceptance. During the past decade, however, the Air Force has gradually expanded the intent and use of warranties to incorporate contract responsibility for performance and maintenance of delivered equipment.[1] Emphasis continues to be placed on applications of warranties in one form or another, with the explicit objective of improving Air Force cost of ownership during the operational life of the equipment.

The importance of this goal, and the trend toward increased use of warranty provisions as a means of achieving it, present the Air Force with a complex array of decisions which must be made in choosing among warranty options. Clearly, contract

1. Colonel Robert J. Lucas and Captain Robert S. Tripp, "The Trend in Warranties," Proceedings of the Fourth Department of Defense Procurement Research Symposium, United States Air Force Academy, Colorado, October 1975.

* The opinions expressed in this paper are solely those of the author and do not represent an official position of the Department of the Air Force.

warranty provisions have a significant impact on Air Force life-cycle costs as well as predictable (and desirable) effects on actual equipment performance. This paper presents a quantitative methodology for analyzing various warrant options in terms of their impact on cost and mission reliability.[2] To fully explain the methodology, we use the existing F-16 Reliability Improvement Warranty (RIW) provisions as a specific example of the applicability of the methodology. Following this, several qualitative issues which bear directly upon the application and usefulness of the methodology are discussed.

BACKGROUND

The F-16 full scale development and production contract contains most the latest mechanisms which are intended to motivate

---

2. This methodology was developed in two Masters theses at the AFIT School of Engineering (Department of Systems Management):

a. Capt T. Koegel and Capt N. Mills, "Analysis of Decision Criteria for the Selection of F-16 Reliability Improvement Incentive Alternatives," Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio 45433, June 1975 (Defense Documentation Center Number AD A014786).

b. Capt A. Doman and Capt A. Dunkerley, "Evaluation of F-16 Subsystem Options Through the Use of Mission Completion Success Probability and Designing to System Performance/Cost Models," Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio 45433, September 1975 (Defense Documentation Center Number AD A021263).

Both thesis efforts were conducted under the direction of Capt Robert Tripp of AFIT/ENS and Capt Dwight Collins of the Joint Air Force Systems Command and Logistics Command Life Cycle Cost Group. A complete description of the methodology can be obtained by reading these documents. The authors are also indebted to Capt Collins for his assistance in discussing this paper and his efforts in outlining the approach to present the material.

contractors to incorporate those design features into the aircraft which will reduce life-cycle costs (LCC). One of these mechanisms is a contractual commitment to make sure that certain desirable target levels of supportability are achieves by such aircraft subsystems as inertial navigation system, flight control computer, heads up display, and so forth. This type of contractual provision is called a Logistics Support Cost Commitment (LSCC) or Target Logistics Support Cost/Correction of Deficiencies (TLSC/COD) provision and is concerned with First Line Units (FLUs). A "First Line Unit" is defined as the first level of disassembly below the system level that would be carried as a line item of supply at base level. Data submitted by the contractor on F-16 FLUs was used to rank FLUs in order of decreasing logistics support costs. Those FLUs which collectively accounted for an estimated 50 percent of the component level support costs were designated Control FLUs and have special contract coverage which is of particular concern here.

A version of the Air Force Logistics Command (AFLC) Logistics Support Cost Model was used to compute projected 15 year Target Logistics Support Costs for each of the Control FLUs, using both Air Force and contractor furnished data. The F-16 contract calls for a verification test, consisting of 3500 flying hours, which begins upon completion of the interim contract support period. Data from this test will be used in the same AFLC Logistics Support Cost Model and a Measured Logistics Support Cost will be computed. If the measured or actual value does not exceed target values, the contractor is eligible for an award fee. If, on the other hand, actual costs are greater than target costs (by 25% or more), the contractor must initiate changes to reduce FLU maintenance and support costs until these costs are within prescribed bounds of contract logistics cost targets. Contractor performance under these provisions is on a Fixed Price Incentive Fee (FPIF) basis. Until the contract ceiling price is reached, the contractor is partially reimbursed (70/30 share line) for those costs associated with the TLSC provision. If total costs to correct exceed the ceiling, the contractor must pay all costs necessary to qualify the Control FLUs in accordance with contract warranty provisions.

The Air Force also has contractual provisions wherein it can select Control FLUs for coverage under a Reliability Improvement Warranty (RIW). FLUs selected for this RIW coverage are to be warranted by the contractor in operational use for 48 months from delivery of the first production aircraft or until 300,000 flying hours are accumulated, whichever occurs first. FLUs which fail during normal operation will be returned to the contractor for repair. RIW coverage is under a Firm Fixed Price (FFP) contract provision. The contractor can increase his profit by incorporating reliability and maintainability improvements into FLUs during the lengthy warranty period.

A further option permits the Air Force to broaden the scope of the basic RIW to include a contractor guaranteed mean time between failures (MTBF). Increasing MTBF values for the 2nd, 3rd, and 4th years of the warranty period have also been specified for each of the Control FLUs. The contractor's obligation under this guarantee provision terminates when actual field MTBF values for two consecutive six month periods exceed the final (fourth year) and highest MTBF value. If the actual MTBF for any measurement period is less than the guarantee value for that period, the contractor must initiate corrective design changes and, in addition, provide additional pipeline spares until it has been shown that guaranteed MTBF are being met. This option is also under a FFP contract.

Finally, in considering the use of either RIW option, the Air Force recognized that FLU level warranty coverage might involve considerable logistics costs associated with carrying a large quantity of FLU spares. In order to retain the RIW concept, if FLU level RIW proved prohibitive, a module level coverage was included as an additional contract option. That is, rather than warranting complete FLU, the Air Force provided itself with an option to enter into negotiations with the contractor for a module level RIW--a further component breakdown beyond the FLU level. Each of the various contract warranty options have the common objective of providing the contractor with the incentive to expressly work to reduce logistics support costs. However, these contractual provisions provide the Air Force and it's contractors with a set of difficult decisions for each FLU. That is, the Air Force must choose one of four contractual provisions for each FLU: TLSC/COD, RIW, RIW/MTBF, RIW at the module level.

The remainder of this paper presents a quantitative methodology which can be used to aid in making these important decisions. For simplicity and ease of presentation, the methodology will not deal with the module level RIW decision alternatives.

ASSESSING THE COSTS OF THE RIW OPTIONS

A primary decision criterion which can be used to analyze the three RIW options TLSC/COD, FLU level RIW, FLU level RIW with MTBF guarantee is the estimated lifetime logistics support cost of Air Force ownership. The basic approach involved in identifying these costs is to sum up the major cost elements for each option using a simplified version of the AFLC Logistics Support Cost (LSC) model. The LSC model sums the following cost elements which are computed by separate equations:

C_1 - Initial and Replacement Spare Cost

C_2 - On-equipment Maintenance Cost

C_3 - Off-equipment Maintenance Cost

C_5 - Support Equipment (Aerospace Ground Equipment (AGE) Cost)

C_6 - Personnel Training and Training Equipment Cost

C_7 - Management and Technical Data Cost

C_8 - New Facilities Cost

C_9 - Fuel Cost

C_{10} - Spare Engine Cost

The LSC model has been found to be most useful to determine order of magnitude differences between estimated costs of ownership under the different alternatives. Depending upon the specifics of the system under study, and the time phasing of the analysis with respect to critical decision, certain of the cost elements above may be eliminated and the model thus reduced and simplified. As an example, suppose for the purposes of analyzing the F-16 contract, the first three cost elements were determined to be the primary costs which would vary between the various RIW options. Then, LCC estimates for each of the options can be calculated based upon mean time between failure of the FLUs for a given set of assumptions such as lifetime of the system and monthly peak force flying hours.

In addition to the initial equipment, spares, and maintenance costs, under the TLSC/COD option, costs to the Air Force are a function of contractor performance. That is, once the logistics support costs as a function of MTBF have been calculated, the MTBF at which a correction of deficiencies (COD) would be initiated must be determined. This COD MTBF is determined by examining the curve to find the MLSC which is the minimum acceptable in the contract and picking off its associated MTBF. At any MTBF's delivered below this critical value, the contractor will incur costs to improve the MTBF. A portion of the costs of these remedies may be shared by the Air Force depending upon the incentive provisions of the contract.

Other costs which must be considered are the cost of including the provision (i.e., the cost inputed by the contractor for the risk of including this provision) and an award fee if subsequent equipment performance dictates.

The costs to the Air Force for the RIW options are of three major types. One cost is the negotiated fixed price for the warranty clause. A second major cost is the cost of spares which are required to cover pipeline and contractor repair cycles. A third cost is associated with Air Force administrative costs for the equipment over the warranty period.

The costs to the government for the RIW with MTBF guarantee option are similar to those of the RIW option. The main difference is that under the RIW/MTBF, low field MTBF's can result in requirements for the contractor to provide a greater number of spares than under the RIW option. If poor equipment performance persists over the warranty period, the spares become the property of the Air Force upon closure of the warranty. This could result in lower life cycle costs to the Air Force than similar circumstances under the RIW provision.

DETERMINING MISSION RELIABILITY

After the costs of the Control FLU RIW options have been estimated, the next step is to determine the effect of RIW decisions on mission reliability. This step is accomplished by utilizing the Mission Completion Success Probability (MCSP) model developed by Air Force Systems Command.[3] The MCSP model is used to: (1) rank the FLUs by the probability of a failure causing a mission abort; (2) analyze the sensitivity of the MCSP with respect to FLU MTBF's; and (3) compute aircraft MCSP as a function of the RIW option chosen. The inputs to this model are: (1) aircraft mission profiles; (2) estimates of FLU MTBF's for each RIW option; and (3) conditional probabilities of aircraft abort given FLU failure for each FLU on various mission segments on the mission profile.

RELATING MISSION RELIABILITY AND COSTS

A Design to Systems Cost/Performance (DSCP) model is next employed to maximize MCSP for a given cost.[4] This methodology essentially selects the combination of RIW options for each FLU which results in a maximum estimated MCSP for a given funding level. Thus, the DSCP model can also be used to identify a number of alternative RIW decisions and their impact on MCSP and the resultant expenditures required to implement the decision alternatives.

---

3. This model is described in detail in "Models and Methodology for Life Cycle Cost and Test and Evaluation Analyses" (OAS-TR-73-6), by R. H. Anderson, et al, Directorate of Aerospace Studies, DCS/Development Plans, Air Force Systems Command, Kirtland AFB, New Mexico 87117, July 1973 (Defense Documentation Center Number AD 782182).

4. Ibid.

Examination of the DSCP model outputs can provide the decision maker with valuable information and guidance which can be brought to bear on RIW decisions. For example, the decision maker can use the methodology to determine the combination of RIW options for each FLU which is estimated to minimize life cycle costs to the Air Force. The decision maker can also use the methodology to determine the impact of alternative selection of RIW options and resultant impacts on cost and MSCP. For instance, the Air Force may opt for TLSC/COD options on all FLUs to maintain a strong organic maintenance function throughout the life cycle of the F-16. If so, the Air Force can assess the cost and mission reliability impacts of the decision with respect to the minimum cost options or the maximum reliability options.

SUMMARY

In today's sophisticated acquisition contracts with RIW provisions, the Air Force will have to décide when and how to exercise these options. This paper has briefly outlined a quantitative methodology which can help to "shed light" on these difficult decisions. The methodology is not a panacea for decision making, but does illuminate the relationship of RIW decisions to life cycle costs and mission effectiveness. This information, when coupled with non-quantifiable data and questions, should aid the decision maker in reaching rational decisions with respect to RIW options.

THE USE OF WARRANTIES IN AIR FORCE PROCUREMENTS - SOME ISSUES OF IMPORTANCE

PERRY C. STEWART
DIRECTOR OF CONCEPTS AND ANALYSIS
AIR FORCE ACQUISITION LOGISTICS DIVISION
WRIGHT-PATTERSON AFB OHIO 45433

INTRODUCTION

This paper presents some of the problems and critical issues encountered with the application of Reliability Improvement Warranty (RIW) agreements in the United States Air Force. For the RIW concept to gain any long-term success, these problems must not only be addressed, but RIW must be integrated as an element of a coherent acquisition management strategy. Too often, concepts like RIW are conceptualized, described as a separate entity, embraced and debated by vocal advocates and opponents, described as either a godsend or precursor of doom, and often left to "wither" on the tree of "too hard to do" ideas. This paper will describe where, in the author's opinion, RIW can fit into the framework of an acquisition management strategy.

The opinions expressed in this paper are solely those of the author and do not represent an official position of the Air Force Logistics Command or Department of the Air Force.

BACKGROUND

RIW evolved from the original failure free warranty (FFW) concept which was initiated on some Navy avionics equipment in the late 1960s. The initial Air Force experience stemmed from application on a displacement gyro for the F-111. Most of the implementation guidance emanating from both Department of Defense and Headquarters Air Force levels in 1974 was based on the limited initial experience with FFW application. The current application of RIW, and indeed even its near term potential, is significantly different from that envisioned by the original FFW concept or described by general RIW implementation guidance.

In many aspects, the original FFW/RIW concept can best be described as marketing technique to enhance the attractiveness of product improvement proposals. A key feature was to provide the opportunity for improving the reliability, and to a lesser extent, maintainability of hardware already in the inventory. While product improvements to existing equipment offer potential benefits to the government, the marginal return is relatively small because the majority of support investment costs have already been incurred.

It is widely believed, and has been reported in several studies, that decisions made early in the acquisition process affect the ultimate commitment of a majority of a system's life cycle cost. One may question the early magnitude of the impact these studies show. Nonetheless, common sense and the high cost associated with incorporating intensive modifications to existing equipment leads to the conclusion that the greatest potential for reducing future support costs requires concentration on the initial design effort for new equipment. In recognition of this, the current Air Force guidelines on RIW state the objective as providing ". . . an incentive to contractors to design and produce equipment which will have low failure rates . . ." The words I have underlined should emphasize that a rather dramatic change has taken place in the potential application of RIW. Current emphasis, and indeed interest, is focused on new systems or equipments which reflect and demonstrate operationally improved reliability and maintainability over their predecessors, or similar type equipment. Specifically, the focus of RIW has changed from a marketing technique for product improvement on existing equipment to an inherent part of the acquisition strategy to design for improved supportability on new systems and equipment.

As could be expected, this change in emphasis has created problems and identified some issues requiring further investigation which were either not anticipated, or adequately defined by original policy guidance on RIW. Some of these "issues" relate to the perception and attitude of current applications of RIW from both the industry and government. To understand some of these viewpoints, let me briefly describe the three principal Air Force programs using RIW.

MAJOR AIR FORCE APPLICATIONS

The first is the AN/ARN-118 TACAN program. This program will result in an ultimate buy of some 8 - 12,000 TACAN units for installation in several different aircraft. The average unit price is in the vicinity of $11,000.

The RIW coverage varies by production option delivery date, but in general provides for a four-year warranty period. A Mean Time Between Failure (MTBF) guarantee which requires demonstration of values between 500 to 800 hours is included. Although a new development item, the TACAN program went through a competitive prototype phase and preliminary reliability qualification testing prior to award of the production contract in early 1975. Collins Radio is the manufacturer and units are currently undergoing initial operational test and evaluation.

The C-141 inertial navigation program is a major modification to incorporate dual INS into the C-141 fleet along with options for purchase of additional units for the KC-135. These units are covered under an RIW which provides for four years of coverage from the delivery of the first unit. Subsequent production options have shorter coverage to provide a common termination point for all units. A single value MTBF guarantee of 1500 hours for the Navigation Unit is provided. Average unit price is in the neighborhood of $50,000 if all C-141 options are covered. Delco Electronics was awarded the contract for delivery of an INS which is essentially a militarized version of their commercial Carousel IV.

The F-16 contract contains an RIW option to be exercised by the Air Force on any of 12 selected avionics items. The items are all subcontracted components for the F-16. RIW coverage is for four years or 300,000 flying hours, whichever comes first. The items are expected to be the primary support cost contributors in the system. Unit costs for various items range from less than $15,000 to over $100,000. An escalating MTBF guarantee is specified for each item. These range from less than 200 hours to over 1,000 hours. RIW commitments were made at the time of award of the production contract, but prior to final subcontractor or vendor commitment. Each component is a developmental item which required complete reliability qualification testing.

INDUSTRY VIEWPOINTS AND REACTIONS

With this background in mind, certain viewpoints can now be discussed. In the fall of 1975, OSD established a Tri-Service Reliability and Support Incentives group to study and investigate a broad range of issues related to reliability improvement warranties. To obtain the viewpoints of industry, a dialogue was initiated with the Council of Defense and Space Industries Association (CODSIA). The Air Force also entered into similar, but somewhat independent discussions with CODSIA during the same time period. CODSIA is an "umbrella" whose members are representatives of both aerospace companies as well as other associations, such as the National Security Industrial Association (NSIA). As such, they represented an excellent vehicle for government-industry communications on subjects of mutual interest like RIW.

Since an additional paper will be presented on industries viewpoints and proposals on RIW at this session, I will only briefly summarize the content of the government discussions and written communications with CODSIA. CODSIA indorsed the government's stated concern and need to obtain more reliable equipment that would cost less to support. They expressed the belief that a properly structured warranty program, with equitable risks and rewards to both parties, could be an element in providing more supportable equipment. They expressed concern, however, over what they believe is a disturbing trend for RIW toward "premature" applications which required the contractor to make a "fixed priced commitment" on equipment whose characteristics "were not reasonably predictable." They felt this trend was growing at an uncontrolled pace and suggested that DOD consider a temporary moratorium on further RIW application.

Before briefly describing the revised RIW concept which they proposed and the service reaction to it, recall again the Air Force applications previously described. None of those programs fits the description of what I termed the "marketing approach" of FFW to improve an existing piece of military hardware. In varying degrees, each does offer the opportunity to "design and produce equipment which will have low failure rates . . ." The C-141 Dual INS, being essentially a modification to a commercially available item, has the least opportunity while the F-16 components requiring development have the most flexibility for design innovations. The greater the opportunity, however, the greater the risk in being able to achieve those commitments. It should be pointed out that risk is by no means solely on the contractor's side. The last thing the government wants is over-commitment and underachievement. The remedies of liquidated damages and consignment spares contained in RIW provisions are only a form of "term insurance", not a satisfactory solution for poor equipment performance.

Recognizing that these types of applications at best incorporated a much higher degree of risk than termed desirable from a contractor's standpoint, CODSIA proposed a modified form of RIW application. This consisted of the following aspects:

a. The establishment of reliability "goals" during full-scale development which would be flexible and subject to some type of incentive, such as an award fee.

b. An expanded reliability task during full-scale development to allow a more seasoned prediction of operational reliability.

c. A "field test before warranty" period to "shake down" the equipment in the operational environment.

d. Upon completion of the field test, a negotiated agreement for a firm fixed price RIW.

Undoubtedly, the proposal if implemented would result in a reduction of contractor risk. From the government perspective, however, it would offer little if any improvement over the original FFW concept. Essentially, it would be a "what you see is what you get" alternative. The Air Force would be in the situation of trying to negotiate an equitable warranty agreement in a sole-source environment. Because of the investment in resources to support poorly performing equipment, any subsequent improvement would have a low marginal return at best due to the magnitude of sunk costs.

The CODSIA proposal should not be dismissed too lightly, however. The underlying premise that a RIW program which was phased to reduce risk by providing the added information available from the evolving development effort is at least conceptually sound.

ADDITIONAL CONSIDERATIONS

There are certain issues that represent Air Force experience which should be described to put a perspective on the CODSIA proposal and enable the development of a concept which may be acceptable to both government and industry. First of all, the RIW concept as currently described in existing guidelines is applicable only to a limited class of equipment. The so-called "high burners", those items having the greatest potential for support cost reduction through reliability improvements, are simply not well suited for application of the RIW concept. The basic reason for this is that government investment in pipeline spares to support the RIW agreement is normally in excess of ultimate spares requirements. The majority of high cost avionics items are packaged to allow a majority of repair to be accomplished at user level. This allows fault isolation, and removal and replacement of internal modules to complete repair on a recoverable assembly, normally termed a Line Replaceable Unit (LRU). The end result is that the pipeline for depot-level repair contains less costly modules, rather than more expensive LRUs. Under RIW, however, the LRU itself must be returned for repair or replacement. This presumes that the support equipment necessary for diagnostic test and repair will be available as scheduled. Unfortunately, because of the complexity of most automatic test equipment and its associated software, this capability has not been achieved as planned. The end result has been the requirement to negotiate Interim Contractor Support agreements.

With these problems, issues, and a divergence of opinion (or maybe objectives) between government and industry, does RIW really have any role in a future acquisition strategy? I believe it does if we put all the facets together. These include the time-phased risk reducing aspects of the CODSIA proposal, the realities of the acquisition environment, and a reasonable incentive mechanism.

INTEGRATING RIW AS PART OF THE STRATEGY FOR SYSTEM SUPPORTABILITY

Basically, I propose a three-phased program somewhat similar to the CODSIA proposal but more oriented toward the transferrance of risk as the program evolves. This would consist of:

a. Full Scale Development - RIW pricing and MTBF commitments associated with any proposed or anticipated production options.

b. Initial Deployment - A one to two year period of Interim Contractor Support (ICS) established on a cost-reimbursement/incentive basis.

c. Operational Phase - A three to four year firm fixed price RIW.

Previous experience indicates that obtaining warranty agreements after competition ends is virtually impossible. Further, it appears impractical to believe that a warranty can be viewed as a separate and distinct profit/loss entity disassociated with the potential production hardware it supports.

I contend that the pricing of a warranty from a contractor's standpoint consists of four elements:

a. The cost of service (repair, replacement, etc.) associated with the equipment if it <u>meets anticipated characteristics</u>.

b. The cost of incorporating potential reliability/maintainability improvements <u>over and above</u> the baseline characteristics.

c. Profit.

d. Risk - Defined as the potential cost incurred if the equipment does not meet the characteristics on which the RIW price is based.

Practically, however, the distinction between these elements becomes "fuzzy" in the overall pricing strategy for a RIW. "Risk" can be incorporated into the anticipated cost for service by considering a higher than anticipated demand rate for the warranted item. Nonetheless, the objective of a revised strategy for RIW should be to reduce the contribution of risk to a level acceptable to both parties. The proposed approach involves a phased reduction of risk to the contractor as design and development proceeds and the amount of information about the product and its potential operational performance becomes more certain.

The submission of proposals for full-scale development would contain a firm fixed priced commitment for RIW along with ascending levels of MTBF. The agreement would provide for specified warranty coverage to begin on each warranted item upon termination of the interim contractor support period. The pricing baseline would include the contribution of the first three elements above (that is, excluding risk). It is anticipated that any pricing would be negotiated at a lower level than currently being experienced on items requiring additional development prior to production. As a "ball park" figure, this would probably run in the vicinity of 3 - 4% of the dollar value of the warranted population on an annual basis. Using the negotiated baseline and the associated initial demand rate and repair cost and pricing data, a fixed priced incentive agreement would be established for the initial interim contractor support period. The ICS target price would be a function of the initial value of guaranteed MTBF and the estimated repair cost.

A high sharing ratio (probably 80/20 or even 90/10) would be used with a similarly high (130-140%) ceiling price. Formal measurements of MTBF would not be made during the ICS period. Contractors would be encouraged to submit engineering changes under the terms of the incentive agreement to correct both observed and potential deficiencies in warranted hardware. The ICS period in this manner would be used as a "risk reduction" phase prior to entering the formal RIW period. Essentially, upon completion of this phase, warranted items would coincide more nearly to the original product improvement agreements under FFW. Payments for the RIW price contribution of previously delivered hardware would be withheld until initiation of the RIW period.

The three to four year warranty period would cover the warranted item (normally a Line Replaceable Unit (LRU)) or any of its lower indenture assemblies. The MTBF guarantee would be against the warranted LRU only. The warranty, however, would allow the Air Force to perform authorized intermediate level maintenance on the warranted LRU. For each warranted failure, the Air Force would return either the LRU or the component module diagnosed as the cause of failure. The incorporation of Elapsed Time Indicators is not practical on most subassemblies or modules. The elapsed operating time would be accumulated from returned LRUs as well as a control group verified by on-site contractor representatives at a single designated base location.

ADVANTAGES OF PROPOSED APPROACH

The modified form of RIW proposed here does offer some advantages to both industry and the Air Force by addressing some of the issues noted earlier in this paper. Among these are the following:

- Firm fixed priced RIW commitments obtained under competitive conditions.

- A risk reduction period to obtain better knowledge of the product and incorporate early corrections.

- Better definition of Avionics Intermediate Shop requirements for deferred delivery over the ICS period.

- A deferral of delivery of depot support equipment until the end of the ICS and RIW period to provide better definitization of requirements.

- A reduction in the dollar value of spares necessary to support the RIW agreement by transitioning from a LRU warranty to a predominantly module warranty.

- A return to the product improvement type pricing baseline for RIW.

Naturally, a compromise proposal such as this does not necessarily correct all potential problems or issues noted. Some of the key issues relate to the practicality of a module-level warranty as described. The Air Force has negotiated provisions for module-level warranties. One of the fundamental questions is whether or not the return of the module alone offers an adequate basis for product performance evaluation to support recommended design changes. Another issue is the effect of the imprecision in the method of MTBF measurement incurred by the sampling procedure.

Nonetheless, it is the author's opinion that a workable framework for incorporating RIW as an element in the acquisition strategy for procuring new equipment can be developed. The concept, described above, may well be the foundation of such a strategy in future Air Force programs.

THE USE OF WARRANTIES IN DOD PROCUREMENTS
SOME ISSUES FROM A DOD PERSPECTIVE

By Martin A. Meth
Directorate for Acquisition
and Support Planning
OASD(I&L)

This paper examines some contractual issues associated with the application of Reliability Improvement Warranties (RIW) in Department of Defense (DoD) contracts, and suggests areas where procurement research efforts could be of benefit.

Background

DoD efforts to improve equipment reliability began in the early 1970's when it became apparent that equipment reliability performance specified in contracts was not being achieved in the field. Differences greater that seven to one were seen when comparing contract to field reliability.[1] The poor field reliability was recognized as a major contributor to decreased weapon system readiness and increased support costs, significant problem areas within the Department of Defense.[2]

The RIW contracting technique was introduced as a means of imposing some responsibility on the contractor for equipment reliability based on its performance in the field. This was a unique approach. Until the introduction of RIW, reliability performance only had been measured prior to delivery of equipment to the government. RIW was first introduced in the form of a fixed price contract, in which the contractor agreed to repair all items returned to him over a rather lengthy period (2 to 5 years). The RIW contract price was based on the expected number of returns from the field, that is the equipment field reliability. The contractor's incentive to improve his equipment field reliability, thus decreasing the number of returns and increasing his profit. The contractor's risk was in the accuracy of his RIW cost forecast at the time he made his bid. These costs were a function of his equipment reliability. The contractor must have been able to project, within reasonable tolerance, what the equipment reliability would be at the start of the RIW period and what the reliability would be during this period.

Because of the various circumstances in which RIW could be applied and the need to balance government and contractor risks[3] careful consideration must be given to the type of RIW contract (fixed price, cost plus) and the best point in time to obtain contractor RIW bids. The remaining portion of this paper is divided into three sections. The first section highlights the present DoD guidelines available to make judgments in the areas discussed above. The second section possess several hypothetical examples using the guidelines, and discusses contractual uncertainties (that are evident) in implementing the guidelines. The final section contains some additional observations and (poses) specific procurement research topics.

RIW guidance

In August 1974 a memorandum[4] was directed to the Services requesting "that a trial application of warranties be utilized in the acquisition and initial operational support of number of Electronic Subsystems to help determine the scope and benefit warranties may have for the DoD, as well as effective management approaches". This memorandum explained that industry extensively used warranties "to provide a usable and available product during a period of time". And, that the warranty approach envisioned for DoD is one which the supplier agrees to repair or replace malfunctioning or defective items of equipment during a specified period of time". In other words the Defense contractor would agree warrant to the reliability of equipment in the field, similarly to what was being done in the commercial world. Other than what is quoted above no guidance was given to the Services with respect to contract type or time to award.

One year later guidelines were issued[5] which included a definition or warranty, its scope, and the contractual elements which should be included in warranty. At this time, too, the warranty technique was given the name Reliability Improvement Warranty. Contractual guidance of interest in the guidelines include:

1. The RIW is a contractual technique which will provide an incentive to contractor to produce reliable equipment.

2. RIW goes beyond the conventional concept of warranty specified in ASPR.

3. RIW shall be fixed price contract line item.

4. There should be a balance between the contractor risks and incentive.

5. "Contractor should be informed early in the design phase that there will be warranty requirements so that he can make important trade-offs."

6. Potential contractors should indicate a cooperative attribute towards acceptance of RIW provision.

available product during a period of time". And, that the warranty approach envisioned for DoD is one which the supplier agrees to repair or replace malfunctioning or defective items of equipment during a specified period of time". In other words the Defense contractor would agree warrant to the reliability of equipment in the field, similarly to what was being done in the commercial world. Other than what is quoted above no guidance was given to the Services with respect to contract type or time to award.

One year later guidelines were issued[5] which included a definition or warranty, its scope, and the contractual elements which should be included in warranty. At this time, too, the warranty technique was given the name Reliability Improvement Warranty. Contractual guidance of interest in the guidelines include:

1. The RIW is a contractual technique which will provide an incentive to contractor to produce reliable equipment.

2. RIW goes beyond the conventional concept of warranty specified in ASPR.

3. RIW shall be fixed price contract line item.

4. There should be a balance between the contractor risks and incentive.

5. "Contractor should be informed early in the design phase that there will be warranty requirements so that he can make important trade-offs."

6. Potential contractors should indicate a cooperative attribute towards acceptance of RIW provision.

In September 1975 a memorandum[6] was issued to clarify and expand the RIW guidelines as follows:

1. For a firm fixed price contract field reliability, potential for reliability growth, and cost to support the equipment, should be "reasonably predictable" at the time a bid is made.

2. For RIW to have maximum effect contractor should be told early in development that a warranty is anticipated. It is desirable to elicit warranty quotes under competition as late as possible in the programs and consistent with the needs for test data associated with each program.

Application of RIW Guidelines

Three common procurement situations where it is believed that the RIW concept has the greatest impact are examined for factors affecting possible selection of contract type other than fixed price and time for RIW bid. Real world situations might contain elements of all three examples. For simplicity each situation highlights specific issues.

A. Development contracts with production options for equipment not within the present state of the art.

Development contracts typically require the contractor to design a new equipment and demonstrate that it meets a performance specification. Development contracts with production options generally indicate that some prior development has been done and the difficult technical problems earlier have been solved or solutions are in hand. In many cases this is the last point at which there exists competition.

Using the DoD guidelines in this situation it would appear that a fixed price option to be exercised concurrently with the production option should be considered, since this is the last point in time when competition would occur. Even if there is no competition, there is still time to influence the equipment design.

The ASPR states that fixed priced contract is applied "where firm and reasonable prices can be established at the outset, such as where the: (iv) uncertainities involved in contract performance can be identified and reasonable estimates of their possible impact on costs made".[7]

ASPR requires a "reasonable" estimate of performance impact on cost. The contractor at the time of development contract is expected to predict the equipment reliability and repair cost. As indicated reliability prediction often fails to correlated with actual field reliability performance. The question is why not? A surface answer might be because it cannot be done. A deeper answer might be because there is no reason for a contractor to make the prediction come true. The RIW now gives him this reason. Whether the contractor can actually make the reliability projection come true, given the RIW motivation, involves a technical judgment. Given that the initial reliability specification is potentially achievable, then a judgment has to be made whether the development schedule and funding, and available field data will support achievement of the predicted reliability.

Assuming there is some doubt above the reasonable predictability then what alternatives should be considered? The ASPR describes three types of contracts - fixed price, incentive and cost. Their application depends on "(i) the degree and timing of responsibility assumed by the contractor for costs of performance, and (ii) the amount and type of project incentive offered the contractor to achieve or exceed specified standards or goals".[8]

In the situation described incentive contracts could be considered as alternative. "Incentive contracts provide for varying degrees of contract cost responsibility, depending upon the degree of uncertainty involved in contract performance."[9] Thus the incentive contracting structure appears to allow for reduction of contractor pricing risks, in certain situations. However, in structuring the incentive contract, a target cost must still be developed. The cost is a function of the equipment reliability, therefore the argument used for uncertainty in fixed price contracts can be equally applied in the case of the fixed price incentive. Though the incentive contract does allow some cost sharing the ceiling prices which are customarily established give the incentive contract the look of fixed price contract in cost overrun situations.

The use of the cost plus contract type in the situation described would not appear appropriate. There is no incentive to the contractor since the government pays the repair costs. The contractor would still get a profit based on his producting the equipment. Also, he would get a number of additional benefits including stability of employed personnel, reduction of overhead, and field information which might be useful for future competition. These advantages would be gained even if the reliability requirements were not met. It would seem that the cost plus contract would have no place in the RIW structure due to its lack of incentive.

An alternative to using different contract types to reduce contractor's pricing risk is to use a pricing formula concept. At the start of the development program the contractor could commit to a fixed price RIW production option with pricing established by prenegotiated pricing formula. The formula price would be determined using the reliability value demonstrated during the development phrase. Thus the RIW fixed price would be based on some known initial reliability value. Though there is some risk as to the reliability values maintained during the warranty period, the overall cost risk to the contractor is minimized by this approach. However this is some question as to the relative degree of motivation the contractor would feel under this alternative.

Finally, consideration of the impact of pricing the RIW under a sole source situation should be studied. It may be difficult without competition to obtain a low enough RIW price to provide the necessary profit incentive. However, even in a sole source situation the contractor is still in sense competing against the government, which has the option of organically repairing the equipment. The contractor might be motivated to compete for the RIW because of the other incentives that would accrue to him, as discussed above in the use of cost contracts.

B. Development contract with no production option.

This contract would generally involve development of equipment where there is a high degree of uncertainity about the equipment performance. This contract could be either sole source or competitive. The issue faced here is how to use the potential of the RIW in a production contract to incentivize a contractor in development. The approaches that have been suggested are to use a "RIW cost goal" similar in nature to a design to cost goal.[10] The development contract would contain provisions such that the development fee would be dependent on the RIW cost in production or alternatively there could be a prenegotiated fee for the production profit of the RIW which would be based on the proposed RIW cost. The uncertainty here is whether the profit incentive is large enough to cause the contractor to try to gain the field reliability and lower support cost at the expense of other parameters. This is an involved question. Studies seem to indicate that profit alone is not the prime incentive which motivates contractor. It was found that contractors would sacrifice short run profit to gain competitive advantage, future production contracts retain personnel, or spread fixed costs over a substantially broader base.

C. Application of RIW to subsystem vendor through a Prime Contractor.

This procurement situation is characterized by a prime contractor who is responsible for development and integration of weapon system with most of the hardware and fabrication efforts performed at a subcontractor level. Generally at the subcontractor level, development is carried out on a sole source basis and contracts are awarded early in the equipment development cycle. The government RIW contract is with the prime contractor.

The issue here is how can the RIW contract terms be structured so that they are effectively passed to the third party hardware designer as well as the prime contractor. The hardware designer must ultimately be incentivized if the design is to be reliable. But it is the prime contractor who has the resources and decides how to pass on the terms and condition at subsystem level. Under these circumstances the hardware contractor might be forced to accept the same RIW terms as the prime contractor, thus greatly reducing the prime contractor risk. Additionaly the prime contractor might not give the designer adequate funding or schedule leeway to meet the reliability requirement. Alternatively the subcontractor might initially accept to accept a warranty because he wants to keep or establish himself in the market place. These circumstances have a high probability of leading to a situation whereby the contractors would not be motivated to complete the warranty provision but rather look for ways out. How to motivate the prime contractor and how to assure that he has fairly passed on the warranty requirements may require new RIW contractual concepts. In addition tighter government control on sub-contractor contract terms and selection should be considered.

A secondary issue arises in the buy-in situation because of the long term commitment required by the RIW and the resultant government dependence on a contractor. These conditions would seem to make a strong case for the government to be assured that a buy-in has not occured either in a subcontractor or direct contract situation. Even though the government can legally accept buy-ins, the possible resultant contract problems caused by the contractor trying to extract himself from his contractual obligation would lead to difficulties which would make the RIW concept unworkable. Therefore contractor negotiators should perform risk/cost analysis of contractor proposals to determine that the cost risk are reasonable to the contractor. Procurement guidelines should be established to determine whether there is a basis in the RIW area for rejection of contractor bid in case of buy-in. This would follow the intent of the RIW guidelines which stated that cooperative spirit should exist in the RIW situation.

Observations and Recommendations

In the past there has been a certain mystique associated with the capability to predict and achieve a specified reliability in the field. Techniques are rapidly being developed which make the prediction and achievement of specified reliability more routine. The demonstration and acceptance of these techniques should resolve many of the current RIW contract problems.

The discussion of the hypothetical situations indicates that implementation and expansion of RIW in the development area particularly for "new" acquistion may require new and unique contracting approaches. Based on the discussion in this paper specific reserach topics suggested are:

o What contract types or contract structures can be used to obtain RIW commitment during equipment development phase? Under what condition should these contract types or structures be used?

o What procedures should the government institute to assure itself that the contractor has an adequate profit incentive in the RIW contract? Consideration should be given to instructing the contract negotiator to assess the development contract for adequacy of funds to support the reliability effort, and analyze the contractor profit potential as a function of reliability variations.

o In the case of a prime contractor who subcontracts the hardware design and production, how should the RIW terms and conditions be structured to provide an incentive to the prime contractor? Should the government reserve the right to approve RIW contract terms imposed on the subcontractors?

Though this paper has discussed the possible use of contract types other than on RIW fixed price contract to reduce contractor risks, the complexity of structuring other contract types and the additional administrative requirements would favor the fixed price approach. An RIW fixed price contract with simple tailored terms[11] would do as much to reduce contractor risk as any of the other approaches considered. Therefore, the RIW fixed price contract should be used as the basis for comparison when studying other approaches.

Footnotes

1. Defense Management Journal, Spril 1976, "A DoD Approach to Establishing Weapon System Reliability Requirements" by Martin A. Meth.

2. IBID, Comment by Jacques S. Gansler.

3. Factors in Balancing Government and Contractor Risks with Warranties by Russell R. Shory. Proceedings of 1976 Annual Reliability and Maintainability Symposium.

4. ASD(I&L)/DDRE Memorandum to the Secretaries of Military Departments dated 17 August 1973, Subject: "Trial Use of Warranties in the Acquistion Process of Electronics Subsystems".

5. ASD(I&L)/DDRE Memorandum to the Assistant Secretaries of the Military Departments, dated 14 August 1974, Subject: "Trial Use of Reliability Improvement Warranties in the Acquisition Process of Electronic Systems/Equipment".

6. ASD(I&L) Memorandum to the Assistant Secretaries of the Military Departments, dated 11 September 1975, Subject: "Reliability Improvement Warranty BRIW) Guidelines".

7. ASPR 3-404.2(b).

8. ASPR 3-401(a)(11).

9. ASPR 3-401(a)(1).

10. This approach was suggested by the Council of Defense and Space Industry Association (CODSIA) in a letter to DoD, dated December 30, 1975.

11. Many RIW contracts have been made more complex with added guarantees on reliability growth or turn around time. If the guarantees are not met, the contractor must provide the government with liquidated damages in the form of additional equipment or money. Thus, in addition to potential losses under the simplified fixed price contract, the contractors cost risked is increased by the added guarantees.

AN ANALYSIS OF THE RELATIONSHIP OF RELIABILITY IMPROVEMENT WARRANTIES (RIW) TO INTERFIRM COMPETITION IN DOD AVIONICS PROCUREMENTS

Lieutenant Colonel Martin D. Martin, Air Force Institute of Technology
Captain Bobby G. Christian, Air Force Institute of Technology
Captain Michael W. Riely, Air Force Institute of Technology

ABSTRACT

Weapon system reliability and maintainability are critical to successful mission accomplishment. A significant managerial concern in the Department of Defense (DOD) has been the need to motivate contractors to develop and produce goods which will meet reliability design specifications, such as mean-time-between-failure. A solution has been the application of the RIW concept. The purpose of the RIW is to motivate contractors to meet and improve the reliability and maintainability of equipment produced to satisfy a DOD requirement. The RIW concept emphasizes the contractor's responsibility for reliability, the potential for reliability improvement based on experience and the possibility for lower life-cycle cost if reliability can be improved. Since 1968 the RIW concept has been applied to six DOD avionics contracts. The items involved on contract include a gyroscope, a gyro platform, and an altimeter. However, some reluctance as related to a broader implementation of the RIW has occurred. This concern relates to the possible impact of the concept on interfirm competition and therefore the industrial base. A research study was undertaken to determine if the degree of competition for RIW contracts differs from the degree of competition for contracts without RIW provisions. The

specific product area investigated was the avionics industry. The basis for this selection was the high unit cost for avionics items, quantity purchases, and the fact that the preponderance of RIW purchases had been in the avionics area. The data base for the research was furnished by the Air Force and Navy. A research design was developed which measured the dispersion of dollar-bids received in response to a solicition and which examined the number of contractors vying for the contract award. The major finding is that no appreciable impact on interfirm competition is apparent as a result of the application of the RIW concept.

INTRODUCTION

The reliability improvement warranty (RIW) is a relatively new procurement approach. It emphasizes the contractor's responsibility for reliability, the potential for reliability improvement based on experience, and the possibility for lower life-cycle cost if reliability can be improved. The RIW contract is normally _ multi-year one. The question has been raised in terms of a given industrial sector as to the possible impact on competition should one firm receive one or more RIW contracts. Therefore, the purpose of this paper is to report the results of a study to determine the impact of the RIW methodology on interfirm competition. For this study the avionics industry was examined.

BACKGROUND

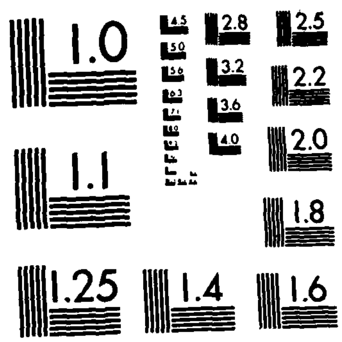
The concept of product reliability is critical to the Department of Defense (DOD). As inflation and other factors have eroded the purchasing power of the dollar, the need increasingly has been to spend available dollars more efficiently. Over time operation and maintenance cost have come to represent 60 to 63 percent of each dollar spent for a weapon system over its life cycle. In order to obtain more dollars for acquisition of weapons in a constrained funding environment, an effort has been made to reduce the amount of money needed for maintenance costs. The situation revolves around the fact that as the mean-time-between-failure (MTBF) increases, the cost of maintenance generally decreases. Therefore, if a contractor can be motivated to increase the MTBF of a given weapon system, then the expectation is that operation and maintenance costs will decrease.

The RIW concept envisons just such a program. The contractor agrees to produce to meet a minimum required MTBF. During negotiation, funds are provided on a firm-fixed-price contract to meet a specified number of service calls based on the average MTBF figure. The motivation for the contractor is the lure of additional profits. Under the terms of the contract, if he can increase the MTBF by design changes, the contractor is in a position to pocket savings as additional profit. After this negotiated period of approximately 5 years is over, the Air Force or Navy, based on the increased MTBF generated by the RIW is in a position to benefit from the higher level of reliability by virtue of decreased maintenance costs.

The RIW was first used in the DOD in 1968. This contract was between the Navy and Lear Seigler, Incorporated. The items involved were

AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76 6/7

UNCLASSIFIED F/G 15/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

gyroscopes ued on the A-4 and F-4 aircraft. The results involved an increase in MTBF from 400 to 523 hours and the hourly cost was reduced from $3.44 to $2.08. In mid 1976 there were seven military RIW contracts. The contractors included Lear Siegler, Inc., Aerosonics Bendix, Collins Radio, General Dynamics, General Electric, Honeywell, and Kollsman. The items on contract were comprised of gyroscopes, radar altimeters, gyro platforms, hydraulic pumps, horizontal situation indicators, attitude and heading reference systems, and TACAN systems (1:13).

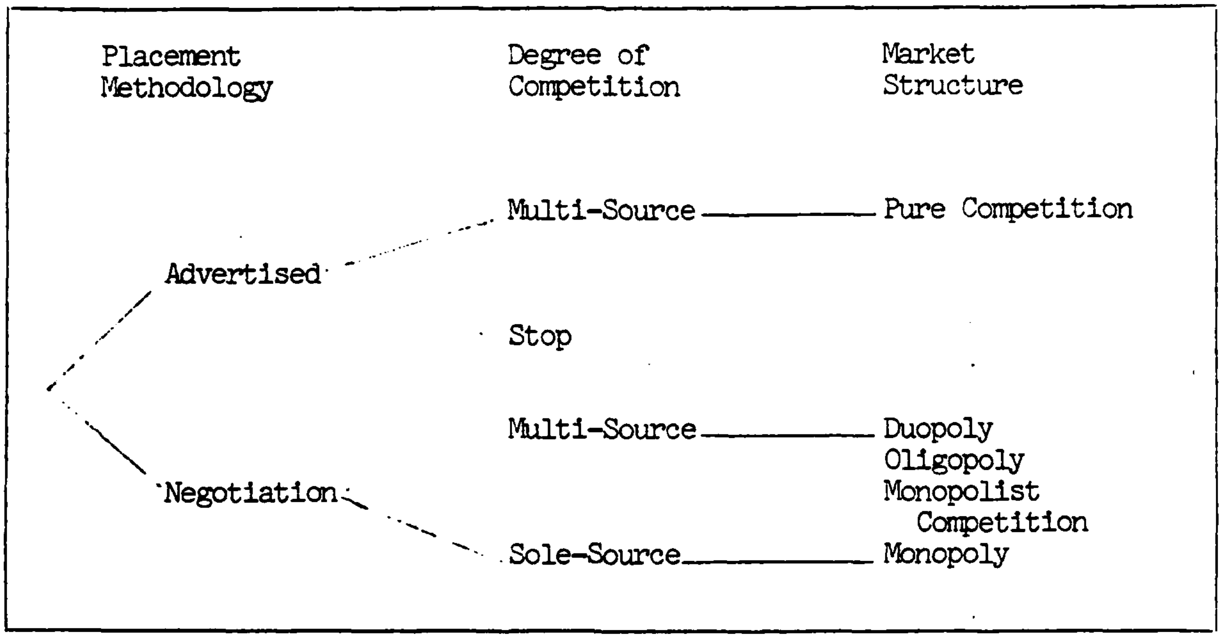
RESEARCH DESIGN AND DATA ANALYSIS

The basic consideration was how to measure competition in order to draw conclusions as to the impact of the RIW on interfirm competition. The DOD procurement process is effected within the limits of the various market structures of economic theory. Advertising with its sealed bids, fairly standard item descriptions, and generally many bidders closely approximates the pure competition model and the seventeen exceptions to advertising which permit negotiation relate to the various forms of imperfect competition, such as oligopoly, monopoly and monopolistic competition. This spectrum is portrayed in Figure 1.

For the study the decision was made to measure competition in two ways. First, the number of contractors responding to an invitation for bids or request for proposal was determined to be a measure of existing competition. For example, with a sole-source procurement only one

FIGURE 1

PROCUREMENT PLACEMENT NETWORK



contractor responds, therefore by definition, there is no competition. The study was not concerned with differentiating responses between negotiated as opposed to advertised procurements. So, to facilitate the analysis and to avoid confusion with the term "responsive contractor" a new term, "respondent contractor" was coined. A respondent contractor was defined as one whose price proposal is accepted by the procuring activity for contract award consideration (1:2). This concept of the number of contractors can readily be extended to the case of pure competition where there are many respondent contractors. Secondly, the variability in contractor price bids was considered as a measure of competition. When competition is keen and contractors are aggressively attempting to obtain a contract, their bids will tend to cluster around some central price (2:405-424). On-the-other-hand when contractors are not actively seeking the contract, it is anticipated that the bids will be dispersed across a general range of price estimates. Of the seven DOD contracts issued on a RIW basis, six involved avionics items. Expectations in DOD are that the RIW method will be most effective in the avionics areas as a consequence of more easily being able to measure reliability (1:8). For these reasons it was decided to deal with competition in the avionics industry.

The basic research design was to measure the extent of competition for two subpopulations. The first subpopulation would be comprised of the six avionics RIW contracts and then a sample of non-RIW contracts would constitute the other subpopulation. The characteristics which define the subpopulations are listed in Table 1. The primary difference between the RIW contracts and the non-RIW contracts was the inclusion in the RIW contracts of a RIW clause.

Data was gathered on-site from both Navy and Air Force sources. It was decided to take a census of the six RIW contracts. These contracts are listed in Table 2. For the non-RIW subpopulation a sample of 27 contracts was taken. Each contract folder was examined relative to the contractor,

TABLE 1

CHARACTERISTICS COMMON TO THE POPULATION OF RIW AND NON-RIW CONTRACTS (1:26)

- All contracts were issued under the provisions of the Armed Services Procurement Regulation.
- Contract prices ranged from $400,000 to $80,000,000.
- Each contract was for nine or more avionics system items.
- All contracts were issued by Aeronautical Systems Division, Electronic Systems Division, Aviation Supply Office, or Naval Air Systems Command.
- Contracts were issued between 1 July 1967 and 31 December 1975.
- Each contract was for the procurement of one of six categories of avionics items:

  a. Gyroscope
  b. Radar Altimeter
  c. Airborne TACAN
  d. Gyro Platform
  e. Horzontal Situation Indicator
  f. Attitude and Heading Reference System

TABLE 2

SUMMARY OF RIW AVIONICS PROCUREMENTS (1:24)

Issuing Agency	Fiscal Year Issued	Category of Avionics Item Procured
Navy Aviation Supply Office Philadelphia, PA	1968	Gyro Platform
Aeronautical Systems Division Wright-Patterson AFB, OH	1969	Gyroscope
	1975	Horizontal Situation Indicator
	1976	Attitude and Heading Reference System
Naval Air Systems Command Washington, D.C.	1974	Radar Altimeter
Electronic Systems Division Hanscom Field, MA	1976	Airborne TACAN

contract number, date of contract award, total contract price, number of items procured, unit price for each item, number of respondent contractors, and the price proposed by each respondent contractor. After the data had been collected and arrayed, statistical tests were conducted to ascertain if the degree of competition was significantly different between the two subpopulations. The first measure, as related to the number of respondent contractors, was evaluated and it was found that the degree of competition did not differ between RIW and non-RIW contracts in any significant manner. This same finding was gleaned from the analysis of the bid-price variability.

Several corollary findings resulted from the research effort. These findings are based on observation, other data collected, and discussions with personnel at the sites visited. While not supported by statistical data analysis, they may be significant to the competition issue.

First, the intensity of competition for RIW contracts appears to be increasing over time. Early procurements had an average 1.5 respondent contractors, whereas, later competitions involved an average of 2.25 contractors.

The second corollary finding is that no consensus of opinion exists among procurement personnel as to the impact of the RIW on competition. Opinions were widely divergent and conflicting. As of the present, no clear trend has been detected by people working in the operational Navy and Air Force environments.

A final corollary finding was that the competition in the avionics industry appeared to be higher than in the general DOD industrial community, as measured by the number of procurements awarded by the advertised as compared to the negotiated placement methodology. For example, the study revealed:

> One of the six RIW contracts (16.7%) was placed by the IFB method. A review of the non-RIW contracts sampled revealed that six of 27 (22.2%) were awarded by the formally advertised IFB method. The percent of contracts awarded by IFB was higher for both the RIW and non-RIW contracts studied than the percent of IFBs for DOD procurements. In 1971, for instance, less than 12% of all DOD contracts were placed by IFB; the remainder were negotiated (1:54).

CONCLUSIONS

Such a study suffers from a lack of available data and the fact that an attempt is being made to evaluate a phenomena while it is happening. This task is not easy and is always open to second guessing. In the case at hand it does not appear that the use of the RIW to date has eroded the DOD industrial base in the avionics sector; however, these contracts are multi-year ones and the total impact may not be ascertainable until much later. As the RIW concept gains more acceptance, it may well be that the competition will become greater. Already, there are some possible indications of this trend. Should one or more contractors start gaining an increasing share of the DOD avionics market on a long-term basis, it might well be that the results of this study would be reversed. At present, however, the RIW does not seem to be impacting on interfirm competition for the avionics sector in any deleterious manner.

REFERENCES

(1) Christian, Captain Bobby G. and Riely, Captain Michael W., "An Analysis of the Relationship of Reliability Improvement Warranties (RIW) to Interfirm Competition in DOD Avionics Procurements." Unpublished Master's thesis, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, 1976.

(2) Peck, Merton J., and Frederic M. Scherer. The Weapons Acquisition Process: An Economic Analysis. Boston: Harvard University Press, 1962.

"THE USE OF WARRANTIES IN DOD PROCUREMENT:
SOME ISSUES FROM AN INDUSTRY PERSPECTIVE"

BY

Ralph P. Wilcox, Manager, Product Support Department
Lear Siegler, Inc., Instrument Division

INTRODUCTION

Industry recognizes the need to fully support the warranty concept of the DOD, to extend the producers responsibility and liability into the operational phase, and to reduce support costs and improve field reliability of military equipment. To accomplish this end, Industry established a CODSIA Task Group to study the objectives of the DOD RIW policy, review the implementing methodology and offer suggestions and recommendations considering those factors which, in our collective position, will provide DOD with an industry recommended base line to implement an RIW program.

This paper deals with the basic issues of RIW contracting, the point in a procurement cycle where RIW should be applied; the various types of contracts that could apply considering the developmental stature of the end product; the details under which the MTBF should be stated; and the subject of applicable failures and/or exclusions in an effort to be equitable to both the Government and Contractor.

RIW ISSUES

During the period between August, 1974 to September, 1975, OASD (I&L) issued memorandums to the Assistant Secretaries of the Military Departments (R&D) & (I&L) on the subject of Reliability Improvement Warranty guidelines. These guidelines were to clarify and expand on DOD current RIW instructions as actual implementing practices by the various procuring agencies did not necessarily follow what is believed to be the intent of the DOD for RIW.

A study of the DOD Memorandums by industry members of CODSIA culminated in the recent report by CODSIA in the letter to Mr. M. D. Bruns of OASD on December 30, 1975. A subsequent study effort completed by CODSIA was in response to Gen. Lowe's RIW "Key Issues". The CODSIA letter to Gen. Lowe of April 23 forwarded the recommendations of industry.

I wish to emphasize that industry fully supports the DOD objective to reduce support costs and improve field reliability of military equipment through the use of RIW concepts. The initial evaluation by industry of the DOD Memorandum was directed primarily at two principal concerns:

1. The premature use of RIW on a firm fixed-price basis in first production contracts for complex military systems involving a high degree of technical uncertainty where no actuarial data exists.
2. Current implementation of the RIW concept by the Military Procurement Services in actual hardware procurements.

In an effort to provide a constructive recommendation we propose that in design, development, and first production contracts the warranty be set up as a separate line item on an incentive cost-reimbursement basis rather than a firm fixed-price basis. In our opinion, the fixed-price approach would be workable only under later production contracts where an MTBF based upon field experience - and not laboratory-controlled reliability demonstration tests - was known and established by reliable field usage data.

The latest DOD Memorandum of 16 Sept. 1976 recognizes a portion of the problem industry can forsee in implementing RIW. Two major DOD criteria for the application of RIW's are that:

1. The field reliability, costs to support the equipment, and potential for reliability growth will be <u>reasonably predictable</u> at the time the firm fixed price bid is made.
2. The terms of the RIW be tailored so that the rewards and risks to both industry and the Government are acceptable.

Of primary importance are the standards or criteria which will be applied in determining whether the factors cited above are "reasonably predictable" for an FFP quotation.

There have been many specific elements of RIW implementing practices that industry has been faced with during the initial introduction phase of RIW. These elements or issues can be reduced to four basic subjects identified as RIW "Key Issues":

- Timing of RIW Application
- RIW Contracting Basis
- MTBF Requirements
- Failures

The sequence is important as we believe the timing of RIW application is the fundamental issue around which the other three issues gravitate.

More specifically, premature imposition of a RIW requirement on development items for which there is little or no field operational usage, MTBF or failure data, on a firm fixed-price basis - in the aggregate - comprises the worst possible combination of risk factors from industry's viewpoint.

<u>TIMING OF RIW APPLICATION</u>

Industry is keenly aware of the need for improved field reliability of operating equipment and feels that one route to the achievement of that goal may be a properly applied RIW program. To achieve this balanced emphasis on reliability and lower operating costs, it is necessary to provide an early incentive which will help insure proper emphasis on lower operating cost during the critical design and development period. It is during this period that the greatest impact on eventual field reliability will be realized.

Three types of RIW programs are suggested which should be considered during the various development phases of a system or program.

1. Parallel Development Program

A parallel development program is defined as one in which two or more competing suppliers are carried through full scale development and at least up to the production decision point (DSARC III).

In such a program, it would be assumed that using RIW would offer not only the lowest possible O&M costs but also an achievement of the lowest Life Cycle Cost (LCC). RIW, then, is a means of bringing more realism to the costing of the operational phase of the program's life cycle.

In the parallel development program, goals for total Life Cycle Cost would be set at the beginning of the program. The competitors would then be encouraged to trade off unit production cost goals against support cost goals including an RIW goal (repair cost) in order to arrive at the lowest LCC. Competition will insure that the RIW and unit production cost goals are optimized. The development phase would then be expanded to include field tests of all competitors hardware using either preproduction prototypes or pilot production hardware built for this purpose. The tests would be conducted in an actual operational environment and using operational type personnel. The results of those tests would assure the realism of the competitor's reliability claims and would at the same time reduce the risk associated with the FFP RIW quote. No incentive is more powerful at this stage than the desire on the part of the competitors to win the production award.

Although this technique requires a larger cash outlay initially, it would no doubt result in the lowest Life Cycle Cost in the long run. It is recognized, however, that the initial outlay of large development funds in our judgement, must be regarded, not as out-of-pocket expense, but rather as investment in the future.

2. Competitive Single Development Program

The competitive single development program is defined as one in which competition exists only through the early stages but not to full scale development. This type of program is most frequently encountered in major weapons systems programs and requires front end money for the RIW requirements.

RIW goals would be set early and would emphasize the importance of reliability and Life Cycle Cost during the critical design and development phase. In this type program, a significant monetary incentive would be applied (not penalty) to the achievement of the RIW goal.

The FFP RIW quote would utilize the operational MTBF determined by field test results.

With this technique, the DOD desire to introduce the RIW concept early enough to influence the design would be satisfied, while at the same time, industry's risk would be reduced to a manageable level.

3. Competitive Production Program

Competitive procurement is defined as procurement of additional quantities of an article already in production and already fielded.

A second definition of a competitive production program is one in which there is a multi-source competition for the production of an article developed by one firm but not yet developed into operational use.

RIW at this phase would not be viable or justifiable because (a) of a lack of potential for reliability growth; (b) the Government would have already invested heavily in organic maintenance - test equipment, handbooks, spares, etc., and (c) in the case of second-source procurement, the bidder who is the original developer would have a competitive advantage over the second source.

For the purpose of RIW, "development" is defined as any program resulting in hardware sufficiently different in form, fit and function from previously developed/deployed hardware as to require a formal design and/or environmental qualification test program prior to the device becoming operational.

RIW CONTRACTING BASIS

Type of Contract

ASPR establishes a wide selection of contract types. At one extreme is the firm fixed price type which is used when there are reasonably definite design or specification requirements and the costs can reasonably be determined. At the other extreme is the cost plus fixed fee type which is used when the uncertainties are of such a magnitude that costs cannot be estimated with sufficient reasonableness to ensure an acceptable risk to the buyer and seller.

It is within this framework that we must look for the appropriate contract type to be used for RIW contracting.

1. <u>RDT&E Design Phase</u>

The design and development phase of any program involves new technology or new applications. It has usually been the practice for the services to contract for this phase utilizing a cost reimbursable type of contract which is compatible with the ASPR.

2. <u>Production Phase</u>

At this phase, without an RIW requirement, the design and specification requirements would have been finalized through adequate testing and the costs of production could be reasonably determined. However, the imposition of RIW on a fixed-price basis at this time introduces unknowns of considerable magnitude and the use of a form of cost-reimbursement contract continues to be necessary during the production phase.

<u>Incentive Structure</u>

DOD, in its incentive contracting guide, states that profit, generally, is the basic motivator of business; and, the profit motivator is the essence of incentive contracting. However, industry and the Government have had both good and bad experiences in the use of incentives. The unsuccessful ones can be attributed to complex incentive structures which were difficult to administer and were manipulated by the parties.

We believe that multiple incentive cost reimbursable contracts - with proper weighing between cost incentives and demonstrated MTBF - can motivate contractors to make trade-offs between increased design costs and lower support costs in favor of MTBF.

<u>Reward/Penalty Relationship</u>

The RIW clauses which we have observed to date in RFP and contracts are, from our perspective, using penalties rather than rewards, to motivate the contractor. We do not mean to imply that rewards by definition are not provided, but the probability of a contractor achieving them are slim particularly if the penalty/reward curve is skewed toward the former.

The following are representative examples of harsh penalties that have appeared in recent hardware procurements:

1. Failure cause exclusions are very limited and the contractor must establish by "clear and convincing evidence" that any of the exclusions are applicable.
2. Contractors are faced with accepting turn-around times (TAT) of 15 to 20 days for complex "black boxes" or risk being non-responsive. Then, if they miss the TAT, they are assessed liquidated damages for each day in excess of the specified limit.
3. Basic to the RIW clause is the requirement for the contractor to repair or replace all units that fail even though caused by Service personnel.
4. The contractor is required to guarantee an initial MTBF with an escalating MTBF value each year through 48 months of warranty. In the event that the MTBF guarantee is not achieved, consignment units are to be supplied at no cost to the Government.

These clauses may not be objectionable to a contractor if field operational test data were available on which to evaluate his risks and base his price.

MTBF Requirement

In considering a contractual requirement for RIW, the anticipated MTBF is the key ingredient in determining the selling price of the RIW Program. In a competitive procurement therefore, in order to insure that all competitors are striving for the same reliability target, it would seem desirable that the Government specify a minimally acceptable MTBF goal together with a growth range (e.g., 800-100 hours). Briefly, the Government would set a tentative value for the MTBF goal and release this to the competitors prior to release of the RFP for their comment and tuning. The RFP MTBF goal would then reflect this value. Inclusion of a growth range would provide flexibility to the competitors in doing their tradeoffs of unit production cost and LCC.

Failure

The key to verification of an operational MTBF is the definition of failure used to compute the MTBF.

Exclusions

The contractor should not be obligated to correct, replace, or propose ECP actions at no cost to the Government with respect to any hardware item under RIW nonconformance, loss or damage by reason of:

(a) Fire, Explosion, Submersion, Flood, Aircraft (vehicle) Crash, Act of God, Consequential/Incidental Damages, Unverified Failures (i.e., the item "retest okay"), Improper Installation/operation/ or maintenance, Seal broken on unit while outside contractor's control.

(b) External or internal physical damage caused by accidental or mis-treatment or tampering by non-contractor personnel.

(c) Induced failures by malfunction or improper operation.

The verification of failure should be performed by a method agreed to by both the Government and the contractor.

Degree of Control, Government vs. Contractor

Interface and authority/responsibility patterns between organic maintenance functions and warrantor must be clearly defined. The Government must be prepared in this area to make hard decisions concerning a possible revamping of traditional organic maintenance and support functions. The field reliability/design loop is best closed by contractor management of field service/design activities.

Timing, Responsibility Vesting

Turn-around time (TAT) for each warranted item should be agreed to by the Government and industry preferably as a range or band of time (e.g., 21-30 days). The TAT "clock" (i.e., start of contractor responsibility) should start upon date of receipt of the warrantable asset(s) as verified by the ACO's representative, at the contractor's repair facility, also to be contractually designated.

TAT performance should be assessed and measured over the whole warranty population and period - not on an individual return basis. Evaluation of TAT performance should be made on the basis of the average of all item returns to determine that such average TAT fell within the contractually established time band.

Retest O.K.

Excessive "retest okay" of equipments are a problem to both the Government (increased pipeline, low availability) and the contractor (cost of testing). Therefore, the Government should be required to pay the contractor for each returned equipment that retests okay.

REFERENCES

CODSIA letter dated 7-2-75 to Dr. Paul F. Arvis, Fort Lee, Virginia.

CODSIA letter dated 12-30-75 to Mr. M. D. Bruns, Chairman, Tri-Service Reliability Incentive Group, OASD (I&L) Pentagon.

CODSIA letter dated 4-23-76 to Brig/Gen. Dewey K. K. Lowe, Hq., USAF, Pentagon.

PROCUREMENT QUALITY ASSURANCE OF COMPUTER SOFTWARE

William R. Leak

Quality Assurance Engineer

Defense Contract Administration Services (DCAS)

The purpose of this paper is to show that conventional means of performing Procurement Quality Assurance (PQA) may never be fully adequate for computer software. I will describe the PQA methods we in the field are using, relate these to the concerns of the Buying Offices, and discuss the limitations of the conventional approach. I will warn you right now that I do not have solutions to offer. In fact this is a cry for help. What we are doing is not adequate, and may never be adequate. I believe that the subject is very much in need of immediate attention, and that entirely new concepts and techniques may have to be found, in order to ensure the delivery of quality software to the Government.

When I use the phrase "computer software", I am referring to the computer program and all of the documentation that accompanies it. You will see in the presentation that the program itself is the primary focus of interest and concern, but the rest of the software has its problems, too, and they are not necessarily of small magnitude.

Now, let's look at the regular areas of activity for a Quality Assurance Specialist.

There are four general areas.

1. The Pre-Award Survey. This is a survey done on prospective contractors, to see if they might or might not have difficulty satisfying the quality requirements of the potential contract.

2. Pricing actions, where the number of hours bid for quality assurance, and costs for those hours, are evaluated before a contract is granted.

3. Surveillance of the management and performance of the contractor's quality program.

4. Acceptance of contracted items offered to the Government.

For computer software, the Pre-Award Survey is the easiest to perform. An assessment is made of the contractor's quality system, the size and qualifications of his Quality Assurance staff, and any history of performance on similar types of contracts. From all this a reasonable estimate can be made as to whether he may or may not have difficulty in satisfying the quality requirements of the contract under consideration.

The next easiest action to perform is pricing. Pricing quality in software may not always be accurate, but it is reasonable. There are published criteria for how much quality is required in a programming effort. The proposed hours can be compared with these standards. The proposed hourly rates can be compared with the contractor's hourly rates for different levels of similar people, such as programmers and engineers. From all this conclusions can be obtained regarding the reasonableness of the proportion of the effort to be devoted to quality assurance, with a minimum of knowledge on the part of the one doing the pricing action.

The other two areas, those of surveillance and acceptance, are much more difficult to perform. Our charter in these areas, in DCAS Quality Assurance, is to accomplish two objectives:

1. To see that only supplies that meet contractual terms are accepted by the Government. This covers all phases of purchasing, production, assembly, and test, so that we know that when we accept an item it meets the requirements of the contract.

2. To ensure that the contractor's corrective action is prompt and adequate. We have systems for review, followup, and escalation of authority to see to this.

It is beneficial to see these two objectives from the buyer's point of view.

A Colonel in an office buying a large computer program system gave me his major concerns, in order of importance:

1. Does it do the job it is supposed to do?

2. Does it do all the job it is supposed to do?

3. Will we know what's in it?

4. Is there one unknown "glitch" that we won't find until too late?

5. Can we keep the schedule?

6. Can we contain the cost?

As I mentioned earlier, the program itself is the area of primary interest. Items 1, 2, and 4 are part of the program. Item 3 applies to the data supplied with the program, such as programmers' manuals, documented code, and configuration, and therefore the ability to correct or modify the program at a later date.

Cost and schedule, while still of major concern, are at the bottom of this short list. Let's look at the ways in which we are presently trying to accomplish our charter, or to satisfy the concerns of the Buying Office.

Surveillance of a contractor's quality program on most software contracts is specified as according to Mil-Q-9858A. This specification gives us the authority to review and disapprove the following:

1. The contractor's Quality Program Plan. Program Plans tend to be general, and of limited value. It is usually very easy for any contractor to put together a plan that we can accept.

2. The nature and implementation of Quality Procedures. These cover two general areas: the handling of software materials, and the production of software.

The first part we can do. We can verify the operation of a program library, and the validation and labeling of program tapes, decks, and disks.

The seconu part, covering the use of quality procedures for the production of software, never seems to work. The production of software bears no resemblance to the production of hardware. It is very difficult to get the contractors to come up with procedures for this, and it looks as if it is just as difficult for him to do it when he tries. The concept doesn't stretch that far. There are too many options in writing code, and too many special cases.

3. Instructions. These don't apply to programming.

4. Standards and conventions. Programming Standards and Conventions are usually specified in the contract. Procedures in accordance with Mil-Q-9858A are not necessary.

5. Special Management Plans, such as Configuration. This can be reviewed, performance can be monitored.

Unfortunately, in computer programming, this plan comes into effect after the majority of code has been written. Published data, such as that in the TRW report given at the Software Management Conference put on this spring by the American Institute of Aeronautics and Astrophysics, et al., show that by the time the code has been written the cost of correcting errors is more than half again the cost of encoding and integrating the system. Some programmers say that the cost of an error may never end. The fix to correct an error may cause a new error, and the fix to correct that causes another new error, and this continues until finally the code is obsolete and discarded. Configuration in software is too after-the-fact. It doesn't reduce the problem, it just tries to keep the problem from getting completely hopeless.

Those are the quality assurance activities we can perform under Mil-Q-9858A.

There is a new specification for software out now, Mil-S-52779. It requires the contractor to implement trackable system for tasking work and scheduling progress.

I have not monitored a software contract under this Mil-spec. I would like very much for this specification to work. It would make our job easier. I have, however, monitored a programming contract on the Cost-System Control Schedule Criteria (C/SCSC), and it hasn't worked so far. Nor has any other District that I know of been able to effectively use C/SCSC for a programming contract. I therefore have some fear that Mil-S-52779, while an excellent idea, may not work in practice.

The last conventional quality assurance function we can perform is in the area of Acceptance. Here a QA man that knows his programming can have an impact. He can review the contractor's test procedures, and verify that they will satisfy the requirements of the prime specification. He can observe the acceptance tests, and assure that they were run correctly. These are standard activities, and they are of value.

At the same time the system does not address the primary problem in testing computer software. It is not possible, in terms of cost and time, to test all elements of a computer program. They are too complex for this. Some compromises have to be made, some shortcuts taken. Often it is assumed that a supporting function in the program is working if the element it supports is working. It is not like a radar that can be slewed in all directions, or an amplifier that can be tested over a complete range of inputs and outputs. Even the complete range of possible inputs to a computer program can often not be tested. There are too many possibilities of them, too.

While every effort is made to exercise a program in every mode considered significant, there is often the specter of the "Unknown Glitch" mentioned earlier. For some systems it can be a very large specter.

You have seen that the conventional means of performing quality assurance is not, and may never be, fully adequate for computer software.

The conducting of Pre-Award Surveys is reasonably reliable.

The performance of proposal pricing actions is also reasonable, provided one has some knowledge of how quality assurance should be performed on software and what level of QA people are necessary to do it.

In the area of surveillance some actions are meaningful, and some are not. The handling and storage of software can be monitored, and the management of Configuration. However, the production of software is not amenable to surveillance efforts, and Configuration usually starts after the major damage has been done.

Acceptance testing can be well conducted by a knowledgeable person, and of benefit, but it doesn't solve the basic problem of the inability to completely test a software system.

It is my conclusion that my basic charter, to see that only supplies that meet contractual terms are accepted by the Government, cannot be adequately performed on computer software, under the present system. I feel that the area needs a new, fresh look. New, and different, concepts and techniques may have to be found to ensure the quality of computer programs. The way in which a software system is specified, designed, built, and tested may have to be done entirely differently from the way it is presently being done. We can't afford the cost of our present mistakes, we can't afford the delays in delivery, and we can't afford to have software that we are not sure of. We need solutions.

Socioeconomic Impacts on the Procurement Process

by

James W. Cisco

I. Introduction

Executive Order 11246 was issued in September 1965 and amended in August 1967. This Executive Order provides for the insertion of the Equal Employment Opportunity Clause in all Federal contracts in excess of $10,000, unless otherwise exempted by the Secretary of Labor or the Secretary of Defense. The Secretary of Labor may exempt a contract for reasons of national interest and the Secretary of Defense may exempt a contract for reasons of national security.

The Equal Employment Opportunity clause requires nonexempt contractors and subcontractors to assure that all employment policies, practices and procedures are nondiscriminatory and to implement affirmative action to assure that employees and applicants for employment are treated equally. As provided for in the Executive Order, the Secretary of Labor issues rules and regulations to carry out the intent of the order. These rules and regulations are published in the Federal Register and incorporated in Title 41 Code of Federal Regulations, Chapter 60. The rules and regulations require Federal contractors and subcontractors with 50 employees and a contract of $50,000 or more to develop and maintain a written affirmative action program (AAP). These written AAPs must contain the requirements indicated in the rules and regulations, e.g., policy statements, dissemination of policy, work force analysis, utilization analysis, identification of problem areas, goals and timetables to correct underutilization and problems identified and an internal audit and report system. Compliance agencies have been delegated the responsibility to review these nonexempt Federal contractors by the Secretary of Labor. If, during the course of a review, it is determined that the contractor is not able to comply with the regulations, sanctions may be instituted after the attempt to persuade, negotiate and conciliate has been made. The sanctions, as provided for in the Executive Order, may result in the cancellation or termination of current contracts or debarment of future contracts. The imposition of sanctions has an impact on the procurement process for social/economic reasons similar to those of delivery, quality, cost and other requirements.

You may question why should socioeconomic programs be tied in with the procurement process. And the question could also be asked why not? The potential for accomplishing social change through the procurement process is far reaching. The Department of Defense (DoD) has identified 35,600 contractor facilities, employing approximately 25 million persons under its jurisdiction.[1] Additionally, in the Fiscal Year 1977 budget, DoD has requested in excess of 40 billion dollars for the purchase of goods and services. It has been projected that defense industry manpower will comprise 4.8 percent of the total labor force in Fiscal Year 1977. Add to these figures the defense construction contractors and the impact for social change is clearly illustrated. During Fiscal Year 1976, excluding Fiscal Year 7T, contractor facilities reviewed by Defense Supply Agency--DoDs compliance arm--hired a total of 863,512 people. Of this total 36.6 percent were female and 24.3 percent were minority.[2] These figures reflect those facilities reviewed by the Defense Supply Agency only and do not indicate the figures for the other nine compliance agencies. It should be pointed out that these statistics were recorded during a period when most economists agree that we are in a period of slowly developing economic recovery.

Recently the program has come under increased criticism by civil rights advocates and women's groups for ineffective government enforcement and by employers for the lack of clear regulations, plus a lack of enforcement consistency by government compliance agencies.[3] There is no lack of agreement on either side that the program does provide for the best possibility for overcoming one of the greatest problems facing the nation today--unemployment of minorities and females. Consequently, the objectives of this paper are to: (1) explore the methods currently being used to accomplish the resolution of these problems; (2) the effectiveness of these methods from a standpoint of goal attainment; (3) the elimination of contractor paperwork burden; and (4) imposition of sanctions other than cancellation or termination suspension or debarment of Federal contractors.

As so succinctly stated by Sir John Slessar in Strategies For The West: "It is customary in democratic countries to deplore expenditures on armaments as conflicting with the requirements of the social services. There is a tendency to forget that the most important social service that a government can do for its people is to keep them alive and free."

Let us face the fact that in a nation as great as ours, there are no problems which we cannot through concerted effort resolve. We have the resources. We have the know how and we have the ability. Do we have the desire? We must if we are to continue to be the leader of nations. We have no recourse other than to expend our efforts in this endeavor. As one sage once stated, "United we stand, divided we fall."

II. Background

Executive Order 8802 was issued on 25 June 1942 by President Franklin D. Roosevelt. This order dealt only with Defense contractors and affirmed the right of all people to work in defense industries "regardless of race, creed, color or national origin." The premise of the Executive Order was that the Government has the right to determine under what terms and conditions it will contract. (The Executive Order has not been subject to extensive judicial considerations, rulings from the Comptroller General and some Federal courts have held that it has the effect of force and effect of the Federal law. Federal law takes precedence when conflict exists between state and federal regulations.)

Executive Orders pertaining to equal employment opportunity have been issued by each President up to the current Executive Order. But it was not until Executive Order 10925 was issued, which established the President's Committee on Equal Employment Opportunity, that the imposition of sanctions and penalties for contractors who did not comply became a reality. Affirmative action by Federal contractors also became a reality under this Executive Order. Government contractors and subcontractors were required to include a nondiscrimination clause and to take affirmative action to assure that employees and applicants for employment were treated equally. Employment records were required to be made available for review. Cancellation and debarment from future government contracts could be imposed in cases of noncompliance. Effective enforcement of the Executive Order was sought through "Plans for Progress" through voluntary agreements developed by leading businesses and Federal contractors.

To further promulgate this impetus, in September 1965, President Lyndon B. Johnson issued Executive Order 11246. This order delegated responsibility for the Contract Compliance Program to the Secretary of Labor and dissolved the Kennedy Administration's President's Committee. The Office of Federal Contract Compliance was created in October 1975, for administration and enforcement of the Executive Order (currently known as the Office of Federal Contract Compliance Programs to provide for the inclusion of the Veteran's and Rehabilitation Act programs).

Executive Order 11246 was amended in 1967 to include the prohibition of discrimination in employment because of religion (in place of creed) and sex.

The basic concepts incorporated under Executive Orders 10925 and 11246, as amended, are the imposition of sanctions and the requirement of affirmative action.

Written AAPs are a recent (1971) EEO requirement of 41 CFR 60-2. During the early days of implementation, compliance agencies provided the contractors with a considerable amount of technical assistance in the preparation of AAPs. As the contractors became more familiar with the development of AAPs the process became more sophisticated and the Equal Opportunity Specialist (EOS) had to become sophisticated in the review of AAPs for compliance. In the formative stages of Equal Employment Opportunity programs qualification requirements for an EOS were primarily in the social science field. Today, in addition to the special qualification requirement to know the causes and effects of discrimination, an EOS should have a thorough understanding of business and industry; plus the ability to analyze statistical data. The Equal Employment Opportunity program has evolved into a full-time job for both the Government and Federal contractors. The question arises, is it effective? This topic will be discussed in a later section which explains the compliance review process.

III. Affirmative Action - A Need

Affirmative action is needed to eradicate discrimination based on race, sex, color, religion or national origin. This is a stated national goal. Perhaps it is time to explain the difference between equal opportunity (a constitutional guarantee) and affirmative action. Confusion sometimes exists in the minds of contractors and others. Don't the two terms mean the same thing? The obvious answer is no. Equal opportunity is a condition and affirmative action is the means by which the condition is achieved.[3]

Affirmative action is needed not only in the areas of employment, but also in the areas of education, housing, public accommodation and voting rights. If true equal opportunity were in existence, it follows that there would be no need for affirmative action and that is the goal of the entire program. Discrimination does exist in this country and many other countries in the world. As late as the early sixties signs still existed designating public accommodations for "Colored" and "White." Employment offices had signs posted, "Colored Need Not Apply." When minorities were hired many were relegated to jobs which were dirty, lowly paid and to those jobs which provided no opportunity for advancement. What are the causes of discrimination? Many scholars have expounded on the causes of discrimination, but it basically stems from a fear of the unknown caused by prejudice. Prejudice stems from prejudgment, and there are many types of prejudice which cause discrimination to take many forms, from the passive to the active. Prejudice may be expressed by word only, but can also take a very active form of violence. The results of these actions can easily be concluded. Someone or many someones are hurt, one way or another. Someone is denied an equal opportunity to a job, to a home, to a school, to a hotel room or restaurant or a right to vote. Without a decent job the breadwinner in a family is unable to provide an adequate place of abode, an adequate education, a sufficient diet and in many instances adequate clothing. These conditions exist in the United States today! The latest Bureau of Census figures indicate that there are 7.9 million nonwhites classified as poor and 17.8 million whites classified as poor. Unemployment and underemployment rates of minorities and women are continuously rising while purchases of supplies and services continue to spiral in terms of dollars expended. In periods of weakening economy, the effects of past discrimination become more self-evident. Seniority in the blue collar work force prevails and the last-in first-out policy takes effect. The effect on women employees is clearly illustrated in Chart 1 which reflectsthe fourth quarter drop-off in 1974.

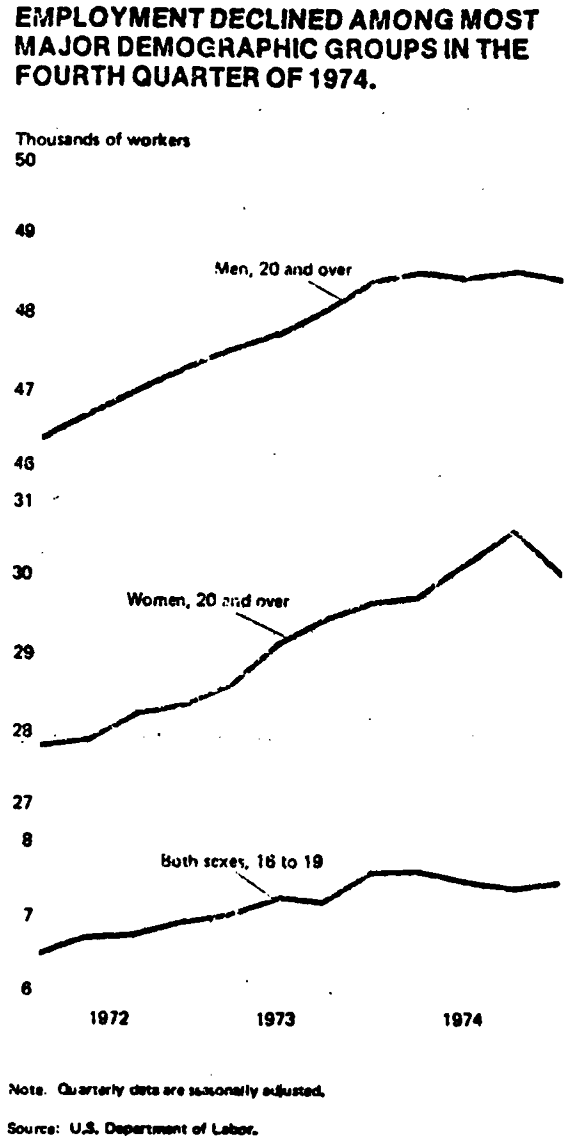
Unequal opportunities do exist and have existed for many years, it thereby follows that the need for affirmative action to relieve these conditions will be necessary for sometime to come.

IV. Affirmative Action Procedures

What is an Affirmative Action Program? How does it work? Code 41 of Federal Regulations 60-2.10 defines an AAP as:

> "...a set of specific and result-oriented procedures to which a contractor commits himself to apply every good faith effort. The objective of those procedures plus such efforts is equal employment opportunity. Procedures without effort to make them work are meaningless; and effort, undirected by specific and meaningful procedures, is inadequate. An acceptable affirmative action program must include an analysis of areas within which the contractor is deficient in the utilization of minority groups and women, and further goals and timetables to which the contractor's good faith efforts must be directed to correct the deficiencies and thus to achieve prompt and full utilization of minorities and women, at all levels and in all segments of his work force where deficiencies exist."

Chart 1


EMPLOYMENT DECLINED AMONG MOST MAJOR DEMOGRAPHIC GROUPS IN THE FOURTH QUARTER OF 1974.
Thousands of workers
50
49
48
47
46
Men, 20 and over
31
30
29
28
27
Women, 20 and over
8
7
6
Both sexes, 16 to 19
1972
1973
1974
Note. Quarterly data are seasonally adjusted.
Source: U.S. Department of Labor.

The procurement process is the means by which this program gains its impetus. The procurement process is the method employed to bring about social and economic change. How is this accomplished? The Department of Labor, through the assignment of responsibility to Federal compliance agencies, monitors the progress of all nonexempt contractors toward meeting the goals stated in the definition of an AAP. When an agency audit of a contractor's AAP reveals serious deficiencies, after persuasion, conciliation and negotiation have failed, the contractor is subject to the sanctions provided. This could result in the delay of needed procurement awards or cancellation or termination of current contracts and debarment from bidding on future contracts. It has been expressed by many procurement officials that this socioeconomic impact impairs their ability to accomplish their mission to provide goods and services to the defense of the country. But let us examine how often this occurs within the DoD compliance program:

	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76
Compliance Reviews	4979	4323	5023	7186	9441	5734	6690	7974
Show Cause Notices	0	75	23	70	64	144	207	131
Debarments	0	0	0	0	0	3	2*	0

*Preaward notices were issued by the Department of Labor. A preaward notice requires that before an award can be made, the Director OFCCP must be assured that the contractor must demonstrate that he is able to comply with the equal opportunity clauses contained in the contract.

An examination of this chart reveals that very little impact on the procurement process is the result of socioeconomic programs. Of a total of 51,350 compliance reviews, show cause notices were issued in 714 instances, or 1.3 percent of the time. Only three debarments were noted. And of those debarments, the contractors failed to request a hearing and a statement that they didn't wish to do business with the Government. Many civil rights advocates might see these figures as a reflection of lack of enforcement. To the contrary, effective negotiation and conciliation bring about the desired results, it may be not as rapidly as some people would like to see. Does the socioeconomic program tie in with the procurement process produce results? Chart 2, which follows, illustrates some of the results of the DoD compliance program. It illustrates some of the progress made through the efforts of the compliance program. This chart reflects both the increases and decreases in employment of contractors reviewed by Defense Supply Agency compliance personnel. To carry the illustration one step further, the gains and losses were multiplied by the median wage reflected in the Manpower Report of the President. The results derived were multiplied by the income tax due for the income derived. As illustrated, the results reflect $234+ million of tax paid to the Government. Someone might say this income would have been obtained anyhow through employment of persons other than employees covered by the Executive Order. This is true. But many of these people would have been otherwise unemployed and part of the great number of recipients of welfare, medicaid, unemployment compensation and food stamps. The costs of these programs are staggering and continuing to grow. The cost of the compliance program for the years shown was $8.9 million, Fiscal Year 74; $9.6 million, Fiscal Year 75; and $10.9 million, Fiscal Year 76 or a total of $29.4 million. It can be concluded that the program is cost effective.

CHART 2

INCREASE OR DECREASE IN EMPLOYMENT FY 74 THROUGH FY 76

FEDERAL CONTRACTORS REVIEWED BY DSA

		FY 74	FY 75	FY 76	TOTAL	NATIONAL AVERAGE X WAGE	=	(000)	NATIONAL AVERAGE X INCOME TAX	=	(000)
Officials and Mgrs	M	5,455 3/	7,230 3/	5,272 3/	17,957	20,000 1/		$359,140	.22 2/		$ 79,010
	F	4,362	7,897	5,791	18,050			361,060			79,433
Professionals	M	5,027	8,967	7,879	21,873	8,800		192,482	.10		19,248
	F	5,020	10,317	8,953	24,290			213,752			21,375
Technicians	M	3,185	5,981	4,204	13,370	7,300		97,601	.08		7,808
	F	2,546	6,145	5,719	14,410			105,193			8,415
Sales Workers	M	555	786	759	2,100	4,600		9,660	.04		386
	F	(962)	(1,121)	(1,825)	(3,908)			(17,879)			(715)
Office & Clerical	M	8,711	11,612	8,349	28,672	6,000		172,032	.065		11,182
	F	(31,236)	(14,861)	(10,489)	(56,586)			(339,516)			(22,068)
Skilled Crafts	M	8,935	13,450	12,332	34,717	8,500		245,094	.098		28,919
	F	2,153	(526)	(4,067)	(2,440)			(20,740)			(2,032)
Operatives	M	29,222	40,100	25,680	95,002	5,000		47,501	.047		2,232
	F	(4,058)	11,636	4,511	12,089			6,044			284
Laborers	M	(2,228)	(1,251)	(2,468)	(5,947)	4,800		(28,545)	.043		(1,227)
	F	1,370	(4,505)	(2,576)	(5,711)			(27,369)			1,176
Service Workers	M	513	886	473	1,872	4,600		8,611	.04		344
	F	391	1,734	1,541	3,666			16,863			674
TOTAL	M	58,349	87,761	62,480	208,590						$234,444
	F	(20,414)	16,716	7,558	3,860			1,450,984			
		3,176,678	3,615,941	2,466,637							

Sources
1/ National Average Wage from Manpower Report of the President
2/ Income Tax from the 1975 Optional Tax Tables
3/ DSA Automated Management Information System

V. Problems With The Current Program

The most difficult area to contractors and compliance agencies is the determination of availability. Since the availability of minorities and women with the requisite skills is the basis for the contractor to analyze his work force and for the EOS to judge the adequacy of the goals and timetables established by the contractor, good demographic data is an essential ingredient for the development of sound AAPs. There are many sources for this type of data, i.e., Manpower Information for Affirmative Action Programs from local state employment security agencies, Bureau of Labor Statistics, Equal Employment Opportunity Commission, Census Bureau, etc. The problem results from the fact that none of these sources agree. Availability data doesn't remain static. Purification of availability data would certainly be considered a worthwhile research project and would be a marketable product.

A second problem experienced in the administration of the compliance program is coverage of the complete contractor universe with the resources provided. Contractors also constantly complain of the paperwork burden imposed by the rules and regulations. The necessity for this paperwork also adds to the cost of doing business with the Government. Lt Col Charles Henry, while serving as Acting Director of Contractor Employment Compliance in the DCASR Atlanta, wrote a thesis on Affirmative Action and included a position which could resolve both of these problems. His proposal is as follows: The Contractor Employment Compliance program should adopt a report system similar to that of IRS. Forms would be developed for the contractor to report his work force data in a modified form. Additional forms would be developed to ask certain key questions about his AAP programs. The current EEO-1, which is required to be filed by all contractors employing 100 or more persons, would be modified to reflect this information. A computer program would be developed into which all of this material would be channeled for analyses, interpretation and conclusions for program direction. Contractor reports would be audited by compliance agencies. Selective criteria would be developed for computer kick-out to require onsite reviews.

The use of this proposal would resolve the problem of complete contractor coverage while easing the present paperwork requirements that bother the contractors. We at Headquarters, Defense Supply Agency are currently attempting to work out the details of this proposal, but in this area of academia any research and development of a system to implement this proposal would be welcomed by both contractors and compliance agencies. A spin-off of this system, by having the data computerized, would be a determination of the results and effect of the program on contractors who have never been reviewed. Does anyone want to accept the challenge?

Yet, another problem is assessment and evaluation of the program in meeting its objectives and goals. Are we accomplishing our mission? What are our goals? A management by objective has been designed to provide better program direction and assessment of accomplishments:

••The system will enable our Headquarters and Regional personnel to calculate the status of program progress at any point by allowing for:

...An audit of the progress of contractors by Standard Metropolitan Statistical Area (SMSA) by Standard Industrial Classification (SIC) on an annual basis.

...An examination of net changes in work force profiles vis-a-vis actual labor area availability.

..The system will enable us to make projections for program accomplishment by allowing for:

...A projected level of achievement in the context of "Ultimate" target.

...A cooperative involvement by Headquarters and Regional personnel in the establishment of long-term targets for net increases in the employment of minorities and women in contractor work forces.

..The system will enable us to determine effective program management by application of resources in light of achievement of results, by allowing for:

...A comparison of goal projections to actual achievement by those regions unable to produce the agreed-upon results.

...A channeling of resources into SMSAs and/or SICs shown to be capable of producing the most significant results in behalf of minorities and women.

A copy of the instruction sheets is attached.

VI. Conclusion

Affirmative Action is a necessity to alleviate the conditions of unequal opportunity. The procurement process effectively brings about social change so very vital to the survival of our great nation. Program improvements are required to provide for a more effective, less cumbersome program. Sanctions other than those currently in being and which are less severe should be developed. Help could be provided through research studies of graduate students if the challenge is there.

FOOTNOTES

1. U. S. Department of Defense, Defense Supply Agency, Equal Opportunity Compliance Report, Cameron Station, Alexandria, Va. November 1976.

2. Thompson Powers, ed., Equal Employment Opportunity: Compliance and Affirmative Action, (New York, New York: National Association of Manufacturers, 1969) P. 65.

3. James C. Hyatt, "All Sides Criticize Law Barring Job Bias by Federal Contractors," Wall Street Journal, 11 November 1975 P. 1.

BIBLIOGRAPHY

Code of Federal Regulations, Title 41, Chapter 60, 1 July 1975, Public Contracts and Property Management, U. S. Government Printing Office, Washington, D. C., 1975, pp 201-330.

Manpower Report of The President including Reports by the U. S. Department of Labor and the U. S. Department of Health, Education, and Welfare. Transmitted to The Congress, April 1975, pp 62, 63.

MANAGEMENT BY OBJECTIVES
Contractor Employment Compliance
Instruction Sheet

Purpose of the Program

The measure of our success in achieving our Contractor Employment Compliance program objective is the presence of minorities and women at all levels of contractor work forces in reasonable relation to their availability in the pertinent labor market. In order to demonstrate we are achieving results, in our results-oriented program, we must determine a relatively **static baseline** for a reviewable contractor universe, establish **targets** in our primary program product - jobs for minorities and women, and establish a **system to audit results** of our efforts to achieve the established target levels. Our Management by Objectives (MBO) program is designed to give better program direction, to use data available in the Automated Management Information System (AMIS), to provide for our Headquarters, Regional Directorates, and DCASMA personnel to establish annual target levels for a five-year period, to evaluate program accomplishment at least annually, and to take necessary management actions to assure meeting or exceeding future goals in the most efficient and effective manner.

Methodology

The employment goals for minorities and women are tied to availability statistics for a given labor area, despite the type of product or service the contractor provides. We have sorted our AMIS data by EEO-1 Category, and by Standard Metropolitan Statistical Area (SMSA), regardless of Standard Industrial Classification (SIC) code, in order to establish a method for tying employment levels to availability statistics. These data sorts are provided in Tab A, and are considered our baseline, or reference point.

The "Availability Factors" for each EEO-1 Category must be obtained for minorities and women at the DCASMA level, under direction of the Region. This number will represent the lowest indicator of availability in that category.

Refer to Sample Chart to Compute Numerical Goals (Tab D), and note the Opportunities Index. The index for the future goal period will be an averaging of the total new hires and promotions in the particular EEO-1 Category during the periods FY 74, 75 and 76. The hire/promotion data are illustrated on the MIS pages, Tab A. The "Labor Force Percentage" is the percent of that particular minority group or women's group cited for the subject SMSA. These data are obtainable from the U. S. Commerce Department, Bureau of the Census. The labor force number represents a form of ultimate goal for each of the EEO-1 Categories. The "Goals" are the anticipated net change in the EEO-1 Category composition which we expect to achieve through compliance reviews, with the resulting percent of representation of the group. The goals will be numbers worked out by the DCASMA personnel, with guidance from the Region, based on the three criteria: Availability Factors, Opportunities Index, and Labor Force Percentage. The goals will be established over a five-year period, by year, beginning with 1 October 1976. Goals will be set to correct only those EEO-1 Categories where minorities and women are not represented in proportion to their availability in the respective SMSA. No goals will be set lower than a 1% increase per EEO-1 Category, per year.

In order to assure that we are measuring the results we have achieved we must evaluate our accomplishments at least annually over the five-year period. This annual evaluation will provide the opportunity to adjust the forward goals based on actual experience and new information concerning availability.

The Recap Charts, Tab B and Tab C, may be used in gaining the perspective needed while Regional and DCASMA personnel work toward their goal setting. The Statistical Profile based on Dun and Bradstreet contractor universe data will be sent to each Region in December 1976, to be used in targeting facilities to be reviewed on a SMSA basis (TAB E). Inasmuch as each Region has already received the D & B data on 3x5 card stock the data is already on hand, and should be in use at the DCASMA level.

Evaluation

This core description of the MBO program for Contractor Employment Compliance is a start. Our Headquarters, Regional and DCASMA personnel will know exactly where the program is at any point by allowing for an audit of the progress of contractors, by SMSA, on an annual basis, and for an examination of net changes in work force profiles as they pertain to actual labor market area availability. In addition, the MBO program will enable us to make projections for program accomplishment by allowing for a projected level of achievement in the context of ultimate target. The net increases in minority and women levels in contractor work forces over the long run will also be measured. We will be able to practice more effective program management, and can apply resources so as to maximize the achievement of results. The program allows for a comparison of goal projections to actual achievements, and a narrative explanation for those Regions which may not be able to produce the agreed-upon results.

PAGES 296 - 306 are not used.

IN-HOUSE OR CONTRACT OUT?
TRACK RECORD AND COST COMPARISON STUDIES

by Fred W. Helwig*

I. INTRODUCTION

Background

The United States does not promote Government ownership of the means of production. In fact, maintaining the viability of the private enterprise economy that has produced the world's most technically advanced, militarily strong and prosperous nation has been a continuing and primary concern of the Federal Government. Accordingly, the executive and legislative branches of Government have long supported the policy that the Government will rely primarily on the private sector of the economy for its needed products and services. However, in order for the security of the nation and its fundamental values and institutions to be protected, the executive and legislative branches recognize that there are circumstances when it is in the national interest for the Government to operate in-house activities to provide the products and services it requires. Office of Management and Budget (OMB) Circular A-76 dated 3 March 1966 and revised on 30 August 1967 contain the basic Government policy statement of reliance on the private sector for needed products and services except in circumstances where (1) program

---

*CPCM, Procurement Analyst, Army Procurement Research Office, US Army Logistics Management Center, Fort Lee, Virginia.

The views set forth in this article are those of the author and should not be construed to represent the official position of the US Department of the Army unless so stated.

delay would result from contracting, (2) direct performance is required for combat support, (3) commercial sources are not available, (4) the requirement can be met by another Government agency, or (5) it can be determined that purchase from a commercial source is not cost-effective.

Objectives

This paper is based on a recent research study conducted by the Army Procurement Research Office (APRO).[1] Two important aspects of the Government's policy of relying on the private sector are addressed. The first aspect involves in-house and contracting out trends within the Department of Defense (DOD) and identifies what is termed the "Make-or-Buy Track Record." The second and more controversial aspect involves the propriety of making in-house and contracting out cost comparisons. Finally, the epilogue summarizes and takes issue with current developments in this area.

II. IN-HOUSE AND CONTRACTING OUT TRENDS

DOD Budget Outlays

To lay the foundation for determining the DOD make-or-buy track record, the changing mix of DOD in-house and contract out funding are examined. The total amount of DOD obligations/expenditures during the period from FY 65 to FY 74 is shown in Table 1. To illustrate the effects of inflation, the figures in Table 1 are show in actual and constant dollars. Inflation and the Viet Nam conflict had a significant impact on DOD's budget outlays from FY 65 through FY 75. During this period the obligation authorities (OA's) that make up the budget fluctuated widely. This is shown by Figure 1 which displays the OA's

TABLE 1

TOTAL EXPENDITURES/OBLIGATIONS

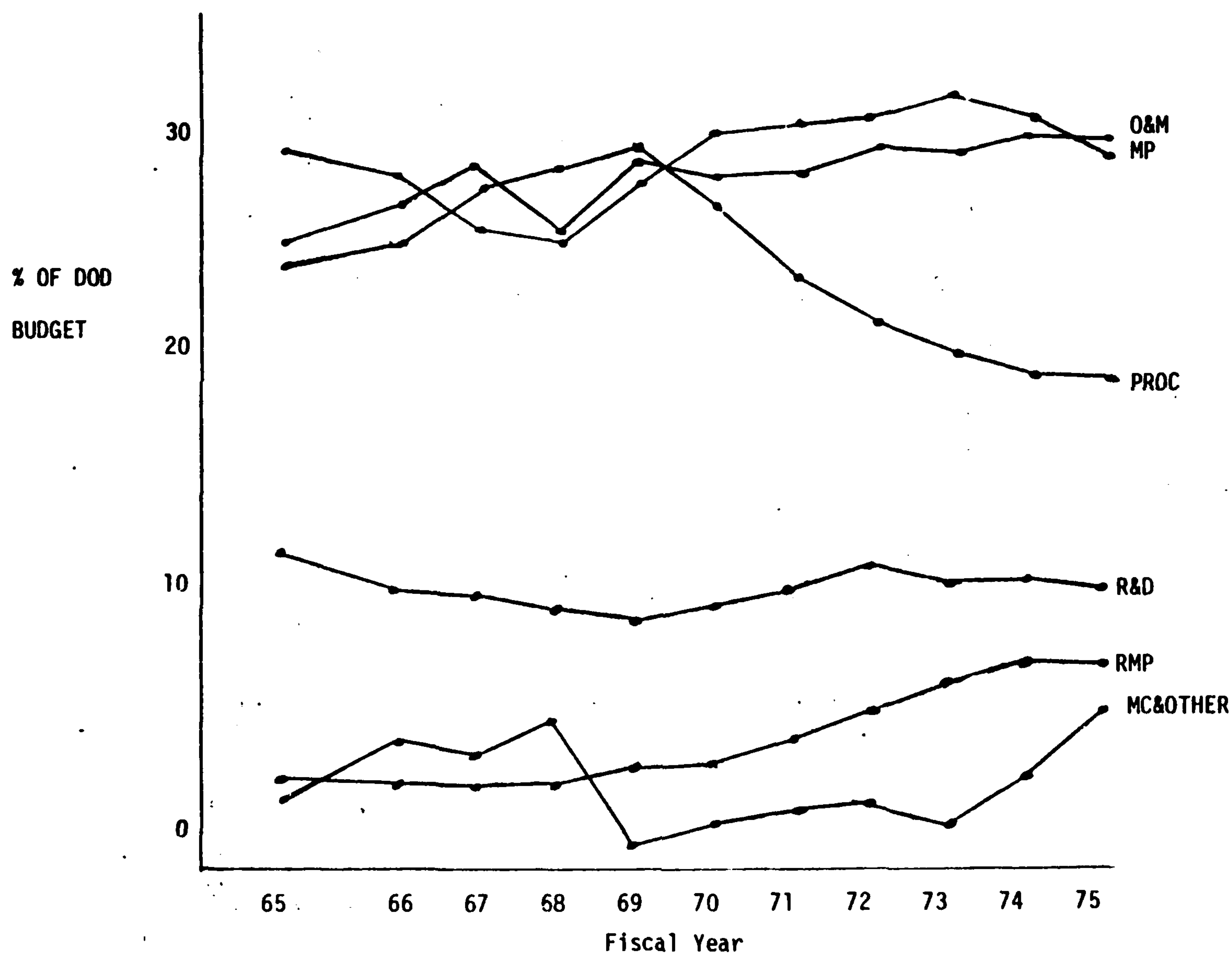
(IN MILLIONS OF DOLLARS)

FY	NATIONAL DEFENSE[1]	
	ACTUAL	CONSTANT[2]
65	53,933	53,933
66	67,750	65,777
67	78,650	75,625
68	83,044	78,343
69	87,003	79,094
70	83,401	73,159
71	81,209	68,821
72	86,877	70,632
73	87,400	62,878
74	93,739	56,469

1] Table FO-2. - Gross Obligations Incurred Outside the Federal Government by Major Function and Major Object Class, Treasury Bulletin, Dept. of the Treasury, Office of the Secretary - Government Printing Office.

2] The Wholesale Price Index was used to convert National Defense expenditure to constant FY 65 dollars.

FIGURE I
Trends of DOD Budget Outlays by Function, FY65 - FY75



within DOD's budget from FY 65 through FY 75. The data that makes up this display is show in Table 2.

One major OA of the DOD budget, procurement, rose from 25 percent in FY 65 to almost 31 percent during the height of the Viet Nam conflict in 1968, but subsequently declined to 19 percent of the DOD budget in FY 75. Thus, procurement which has traditionally been the largest element of the DOD budget going directly to the private sector has declined significantly below its pre-Viet Nam percentage. This substantially reduced the opportunity for directly channeling money into the private sector through purchasing.

Some elements of the DOD budget such as military personnel (MP), retired military personnel (RMP) and operation and maintenance (O&M) have gradually increased as a percent of the total DOD budget. As these elements of the DOD budget have increased there are fewer dollars remaining for areas that DOD has traditionally contracted out. One major and traditionally in-house element of the DOD budget is O&M. Industry alleges that O&M funds primarily support commercial/industrial-type activities (CITA)[2] and insists that more of this OA as well as the OA for research and development (R&D) be contracted out. Equally adamant in their position are Government employee unions which support existing in-house expenditures in these areas.

Make or Buy Baseline

In order to establish a baseline for making in-house and contract out comparisons, the budget OA's were examined for their "potential of contracting out." Based on an analysis of the DOD budget, the functions of DOD, and how the budget is expended, it is recognized that

TABLE 2
DOD BUDGET OUTLAYS BY FUNCTION, FY65 - FY75 (in millions of dollars)

FUNCTION	FYs (ACTUAL DOLLARS)										
	65	66	67	68	69	70	71	72	73	74	75
MILITARY PERSONNEL	13,387	15,162	17,956	19,859	21,374	23,031	22,633	23,036	23,246	24,081	24,428
% OF TOTAL DOD BUDGET	29.1	28.0	26.6	25.7	27.4	29.9	30.4	30.7	31.7	30.7	28.9
RETIRED MILITARY PERSONNEL	1,384	1,591	1.830	2,095	2,444	2,849	3,386	3,885	4,390	5,145	5.685
%	3.0	2.9	2.7	2.7	3.1	3.7	4.5	5.2	6.0	6.7	6.7
OPERATION AND MAINTENANCE	12,349	14,710	19,000	20,578	22,227	21,609	20,941	21,675	21,069	23,306	24,917
%	26.9	27.2	28.2	26.6	28.5	28.0	28.1	28.8	28.7	29.7	29.4
PROCUREMENT	11,839	14,339	19,012	23,283	23,988	21,584	18,858	17,131	15,654	15,144	16,359
%	25.8	26.5	28.2	30.1	30.8	28.0	25.3	22.8	21.4	19.3	19.3
RESEARCH & DEVELOPMENT	6,236	6,259	7,160	7,747	7,457	7,166	7,303	7,881	8,157	8,414	8,890
%	13.6	11.6	10.6	10.0	9.6	9.3	9.8	10.5	11.1	10.7	10.5
MILITARY CONSTRUCTION AND OTHER	928	2,279	2,636	3,975	525	1,059	1,552	1,655	895	2,476	4,617
%	2.0	4.2	3.9	5.1	0.7	1.4	2.1	2.2	1.2	3.2	5.5
TOTAL	45,973	54,178	67,457	77,373	77,872	77,150	74,546	75,151	73,297	78,400	84,600

SOURCE: The Budget of the U.S. Government, Washington,D.C.: U.S. Government Printing Office.

many functions performed by DOD should not be classified as CITA and should not be contracted out.

In establishing a make-or-buy baseline, it would seem reasonable to exclude those portions of the DOD budget that are primarily other than CITA. Certain OA's, i.e., MP and RMP, have limited contract out potential. Therefore, for comparison purposes, OA's for MP and RMP were eliminated from the baseline being developed.

The OA for RMP is a Government financial obligation and is obviously not subject to being contracted out. In an analogous situation, the retired pay of former civilian employees of the DOD is not included in defense budgets, but is separately identified and funded in non-military accounts. The OA for MP has more contracting out potential than the OA for RMP. However, most military assignments are considered to be in direct support of combat or readiness requirements, including rotational requirements, and are therefore not suitable for contracting out. This generalization is supported by the FY 73 Annual CITA Inventory which includes 103,834 military man-years of effort within the DOD. This "potential of contracting out" is only 4.2 percent of the total military man-years available. It is acknowledged that some military personnel are performing commercial or industrial-type functions (CITF). During peace time however, skills must be developed and maintained in anticipation of mobilization. Also since the U.S. must maintain a minimum level of troop strength during peace time, such labor may be largely wasted if not gainfully employed in a CITF.

Therefore, the make-or-buy baseline has been arbitrarily, though logically, established as the total budget less the OA's for

MP and RMP. For comparison purposes, this baseline is given in constant and actual dollars in Table 3.

Contract Out Resources

Now that a make-or-buy baseline has been established, the next step is to identify and quantify contract out and in-house resources. On the contract out side, the most meaningful DOD indicator of contract out resources is contained in the contract award information reported on DD Form 350, Individual Procurement Action Report, and DD Form 1057, Monthly Procurement Summary by Purchasing Office. The total amount contracted out in actual dollars since FY 65 for the DOD is shown in Table 4. To eliminate the effects of inflation on the defense budget, Table 4 converts contract out dollars to a constant dollars with FY 65 as the base year.

In-House Resources

Since contract out resources have been identified, it is easy to identify in-house resources. This is accomplished by subtracting actual contract out resources from budget totals less the OA's for MP and RMP. Table 5 contains the results of this computation and converts the results into constant dollars with FY 65 as the base year.

The salaries, fringe benefits and overhead expenses of civilian employees within the DOD account for most in-house resources. Although it is recognized that military personnel in some cases, perform jobs similar to those performed by civilians or contractor employees, the number of military employees is considered to be primarily a function of military readiness or combat rotational requirements. Therefore, expenditures for military personnel are excluded from the in-house

TABLE 3

MAKE-OR-BUY BASELINE 1]

(IN MILLIONS OF ACTUAL AND CONSTANT FY 65 DOLLARS)

National Defense (DOD) 2]		
FY	ACTUAL	CONSTANT
65	39,162	39,162
66	50,997	49,512
67	58,864	56,600
68	61,090	57,632
69	63,185	57,441
70	57,521	50,457
71	55,190	46,771
72	59,956	48,745
73	59,764	42,996
74	64,513	38,863

1] Military and Retired Military Personnel are excluded from DOD expenditures. A portion of these obligations go to the private sector mainly through PCS and TDY funds. It would be theoretically possible, but not realistic or feasible, to contract out 100 percent of this portion of the Defense budget. This baseline was selected since precise data is not readily available for development of a more refined baseline. In fact, several categories of Defense spending, e.g., military intelligence and certain headquarters staff functions, are not readily subject to being contracted out and could be excluded from the baseline. However, due to the lack of precise data, the estimation of these categories and amounts was not made.

2] Table FO-2. Gross Obligations Incurred Outside the Federal Government by Major Function and Major Object Class, Treasurer Bulletin, Dept. of the Treasury, Office of the Secretary, US Government Printing Office.

TABLE 4

CONTRACT OUT RESOURCES
(IN MILLIONS OF ACTUAL AND CONSTANT FY 65 DOLLARS)

	DOD 1]	
FY	ACTUAL	CONSTANT
65	27,997	27,997
66	38,243	37,129
67	44,632	42,915
68	43,756	41,279
69	41,986	38,169
70	35,977	31,559
71	34,517	29,252
72	38,292	31,132
73	36,920	26,561
74	46,131	24,175

1] Defense dollars contracted out were obtained from Military Prime Contract Awards, obtained from DD Form 350s OASD (Comptroller). One should note that ASPR 21-102(b) on the Individual Procurement Action report (DD Form 350) does not require certain expenditures to the private sector to be reported.

TABLE 5

IN-HOUSE RESOURCES
(IN MILLIONS OF ACTUAL AND CONSTANT FY 65 DOLLARS)

FY	DOD	
	ACTUAL[1]	CONSTANT
65	11,165	11,165
66	12,754	12,383
67	14,232	13,685
68	17,334	16,353
69	21,199	19,272
70	21,544	18,898
71	20,673	17,519
72	21,664	17,613
73	22,844	16,435
74	24,382	14,688

1] In-house resources equals gross National Defense expenditures less expenditures for retired and military personnel, and less actual contract out resources.

resources computation for the same reason that the salaries and pensions of such personnel were excluded from the make-or-buy baseline.

In actual and constant dollars, in-house resources within DOD have increased since FY 65. In-house resources in terms of the number of DOD civilian employees have generally remained constant or have decreased during this period. Table 6 illustrates this paradox and also includes the number of military personnel for comparative purposes.

One plausible reason why DOD in-house expenditures (Table 5) increased while the number of DOD civilian employees (Table 6) decreased, is that the pay of Federal civilian employees has significantly increased as the result of Congressional mandate that civilian employees achieve pay comparable with private industry. In fact, the Economics of Defense Spending reported that the Civil Service payroll increased by 69.6 percent from FY 64 to FY 73. To determine whether wage comparability accounted for this discrepancy, the average gross weekly earnings in private non-agricultural groups for 1963 and 1964 were compared with 1972 and 1973 (average of two years to account for fiscal instead of calendar years). This comparison showed an increase in the private sector of 55.7 percent during this time period. Attempts to refine the in-house and contract out indexes to account for wage increases were considered, but it was soon realized that all available indexes have shortcomings and none are completely satisfactory for make-or-buy adjustments. However, any of the reasonably applicable indexes, e.g., consumer price index, wholesale price index and labor wage rate indexes,

TABLE 6

NUMBER OF DOD & AMC MANPOWER
(PERSONNEL IN THOUSANDS)

FY	DIRECT HIRE CIVILIAN EMPLOYEES DOD	ACTIVE DUTY MILITARY DOD
65	1,034	2,655
66	1,138	3,094
67	1,303	3,377
68	1,317	3,584
69	1,342	3,460
70	1,194	3,066
71	1,127	2,715
72	1,083	2,323
73	1,031	2,252
74	1,070	2,162
75	1,034	2,129

SOURCES: Selected Manpower Statistics (DOD Comptroller) and Commanders' Digest.

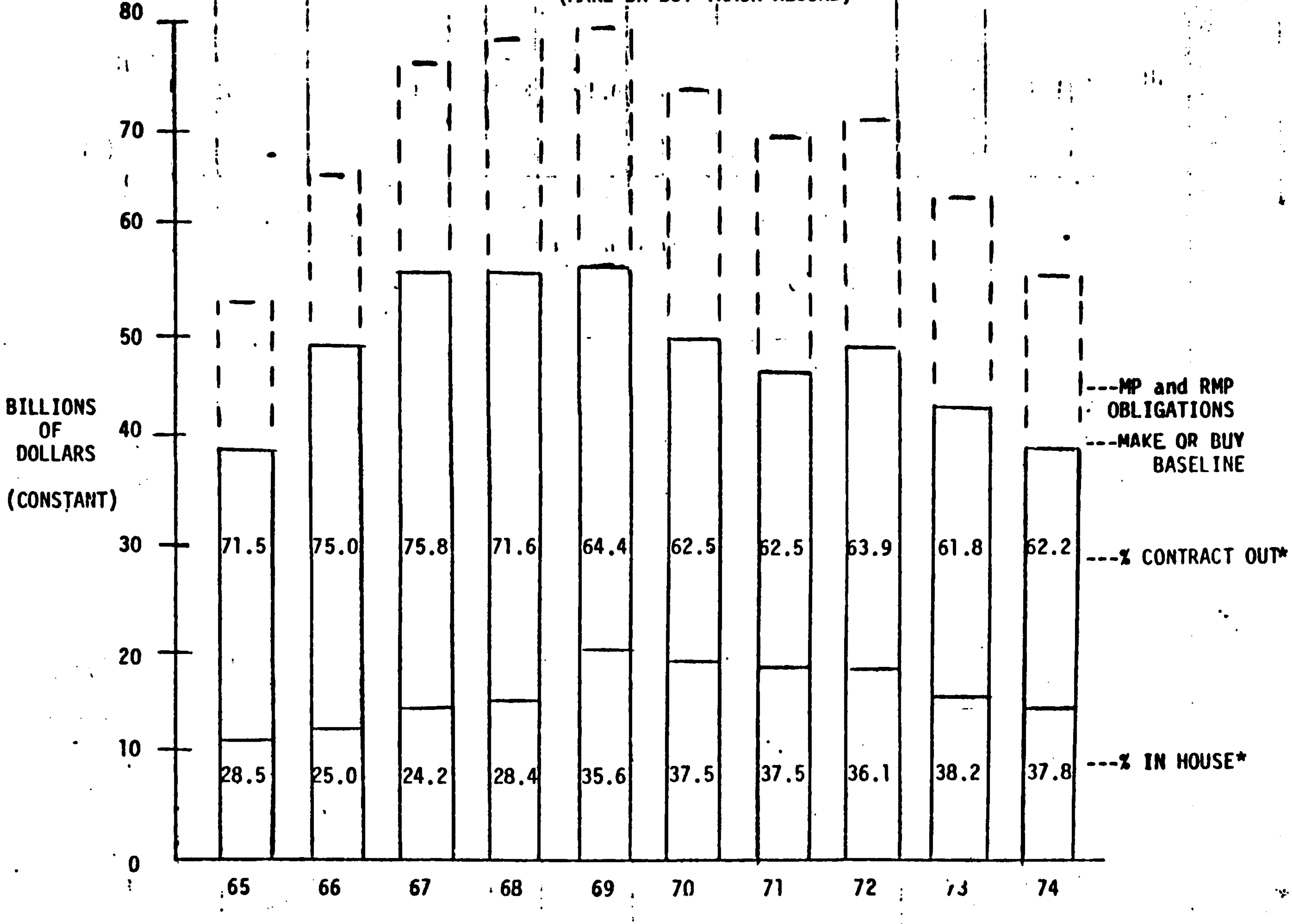
yield the same general trends and refinement or substitution of indexes would not appreciably change the make-or-buy trends which will now be identified.

Make-or-Buy Trends

Now that a make-or-buy baseline has been established and the in-house and contract out resources have been identified, trends for DOD obligations may be portrayed. To eliminate the effects of inflation, constant FY 65 dollars are used to show the relationship of in-house and contract out resources to total DOD obligations. This relationship is summarized in Figure 2. Figure 2 reveals that in constant dollars defense spending is about the same in FY 74 as in FY 65. In actual dollars both the Government and the defense industry have fewer dollars now than in pre-Viet Nam days, but the defense industry has borne more of the burden of reduced defense spending. This shifting of resources between the private and public sectors since FY 65 is easily discerned. For DOD, the percentage of available make or buy resources going to the private sector has decreased from 71.5% in FY 65 to 62.2% in FY 74.

The make-or-buy track record (Figure 2) is merely a general indication of the in-house and contract out obligations and expenditures of the DOD. The definition of in-house resources is admittedly very broad and includes management and other overhead expenses not required to be reported by OMB Circular A-76. A more direct approach to identifying in-house resources would be to examine the annual DOD CITA Inventory Reports. Table 7 contained a summary of the in-house CITA amounts reported by the DOD, Army, Navy, Air Force and DSA

FIGURE 2. BREAKOUT OF DOD TOTAL OBLIGATIONS
(MAKE-OR-BUY TRACK RECORD)



*See Footnote on page 46

TABLE 7

DOD CITA ANNUAL OPERATING COST AND INVESTMENT

(IN MILLIONS OF DOLLARS)

AGENCY	FY	CIVILIAN MANYEARS	MILITARY MANYEARS	MATERIAL DOLLARS	TOTAL DOLLARS	PLANT AND EQUIP DOLLARS
ARMY	72	89,986	18,361	398	1,526	3,475
	73	89,489	18,559	410	1,637	5,059
	74	96,780	17,143	439	1.746	4,658
AIR FORCE	72	88,232	53,968	288	1,746	2,145
	73	77,787	59,597	258	1,656	1,764
	74	71,770	58,405	266	1,640	1,885
NAVY	72	115,106	17,990	628	2,192	3,710
	73	98,379	17,643	408	1,842	3,645
	74	97,419	17,513	418	1,988	3,709
DSA	72	7,087	41	13	88	51
	73	7,589	36	14	101	62
	74	7,274	34	14	126	73
TOTAL* DOD	72	305,258	98,978	1,346	5,660	9,690
	73	277,702	103,834	1,113	5,362	10,865
	74	278,012	99,933	1,159	5,643	10,666

SOURCE: DOD CITA INVENTORY

*Includes DNA, DCA, Marines

from FY 72 to FY 74

Attempts to establish make-or-buy trends from data such as contained in Table 7 was considered. However, the number of unapproved reports (36.1 percent during FY 75) and the inconsistencies in defining and reporting CITA severely limited its usefulness. Therefore, it was decided that a broad definition which included CITA as well as other in-house resources would establish general in-house trends. On the contract out side, the same problem exists, but it is even more pronounced since contract out CITA is only partially reported. Also the contract out resources identified by this paper are more encompassing than merely contract out CITA. Therefore it was reasoned that the all encompassing definitions of in-house resources and contract out resources would at least help establish general trends and give a more objective prospective on implementation of the general policy contained in OMB Circular A-76.

Although of questionable value, Table 7 reveals that the in-house DOD effort in 1974 of \$5.6 billion was less than the \$5.7 billion expended in 1972. This would be a significant reduction in total in-house DOD effort if FY 74 dollars were converted to constant 1972 dollars.

Another major point is that the FY 74 DOD CITA inventory shows that \$5.6 billion was expended in-house. Table 4 showed that \$24.4 billion was expended in-house. This is a net difference of \$18.8 billion and brings up an important question. How much of this is CITA and should have been reported on the CITA inventory? The definition of CITA is definitely a problem and is one reason why the DOD CITA

Inventory was not used to develop the Government's make-or-buy track record.

III. IN-HOUSE AND CONTRACTING OUT COST COMPARISONS

Cost Analysis

The fifth exception to the buy policy stated in OMB Circular A-76 allows in-house performance of a function if procurement of the product or service from a commercial source will result in a higher cost to the Government. For the military services to determine which method of performance is least costly to the Government, a cost analysis must be conducted. It is intended that

> . . . a decision, based on costs, to start or continue an . . . activity must be determined by a cost analysis which is truly comparable, and which takes into consideration overall total Government costs, both direct or indirect.[3]

Understandably, many questions exist concerning current guidelines on how to prepare a truly comparable cost analysis. This paper challenges the practicability of conducting a cost analysis which is truly comparable under the current guidelines or any guidelines.

Cost Analysis Methods

This paper identifies four different cost analysis levels and corresponding methods which may be used for comparing in-house versus contractor performance. These are termed the (1) out-of-pocket cost method, (2) incremental cost method, (3) full cost method, and (4) socio-economic cost method. Each of these methods which are described below progressively considers additional cost factors.

a. Out-of-Pocket Cost Method. To compute the in-house cost of performance considering just first level costs, only actual out-of-pocket expenses are included. Cost factors such as depreciation, interest, insurance, and taxes are excluded. Obviously, this method favors in-house performance since these cost factors are real expenses to a potential contractor and must be included in his proposal. The CITA program does not advocate the use of this method of cost analysis, but it is properly used under the Arsenal Statute to compare ammunition production costs of private industry versus GOCO plants.[4]

b. Incremental Cost Method. Considering only incremental costs also favors in-house performance but to a lesser degree since additional cost factors are included in the Government's estimate cost. OMB Circular A-76 primarily addresses this method of cost analysis. Under the incremental method, a number of cost factors such as all Government sunk costs and some overhead costs are ignored. Only the additional expenses directly related to performance of the function under review are included in the in-house figure. For example, depreciation is computed as a Government cost for any new or additional facilities or equipment but not for existing facilities and equipment. Excluding such cost factors may result in a cost analysis significantly favoring in-house performance. Although the incremental method includes more Government cost factors than the out-of-pocket method, it does not include as many as the full cost method.

c. Full Cost Method. Under the full cost method an attempt is made to quantify all costs directly incurred by the Government in performing the function. Thus, additional cost elements such as depreciation on existing facilities and equipment and the cost of support services are estimated as part of the in-house cost.

The following example illustrates the potential difference in results depending upon the cost elements included in the analysis. It is from an Atomic Energy Commission cost study in 1966 of an activity which provided laundry service. The cost figures are for one year of operation at three bases.[5]

Full Cost Recovery	$261,094
OMB Circular A-76 Guidelines	182,080

The A-76 figure is lower primarily because it excluded a proportional allocation of overhead and depreciation on existing facilities.

Figure 3 dramatically illustrates the difference in results depending upon the cost method chosen when applied to hardware production.[6]

FIGURE 3. COMPARISON OF TWO COSTING METHODS

FULL COSTING:	Unfinished Part	Finished Part
Commercial Procurement	$316.95	$471.37
In-house Production	319.43	466.43
INCREMENTAL COSTING:		
Commercial Procurement	312.45	466.87
In-house Production	145.43	195.48

Certain costs indirectly incurred by the Government are excluded from even the full cost method as being inappropriate or not quantifiable, but these are costs to the Government and therefore the taxpayer in the long run. The last cost method, socio-economic cost, considers these heretofore unaddressed cost factors.

d. Socio-Economic Cost Method. An analysis at the socio-economic cost level considers all costs, directly and indirectly incurred by the Government, in estimating in-house performance costs. Included are such factors as lost federal, state, and local income taxes, employee morale, performance quality differences, unemployment costs, and other benefits. Since most of these factors are not quantifiable, it is impossible at this level to obtain accurate estimates of in-house versus contractor performance costs.

Cost Method Employed Within DOD[7]

There are two costs that must be calculated to complete cost analysis within DOD: (1) the cost of Government Operations (make) and (2) the cost of Contractor Operations (buy). A third cost, Government Operations-Other, is also allowed but this alternative is seldom used and is not addressed by this paper.

a. Government Operations. Although DOD implementation of OMB Circular A-76 basically prescribes the incremental cost analysis method to compute in-house cost, the analysis is not totally confined to costs at the incremental level, nor does it include all costs at the incremental level. It selectively crosses all cost levels. For example, federal taxes (at the socio-economic cost level) are considered, but state and local taxes are not; depreciation of new facilities is included but depreciation on existing facilities (full cost level) is not; and direct personnel salaries are included but all personnel overhead (incremental cost) is not. Figure 4 illustrates the set of cost factors included in the DOD cost analysis.

b. Contractor Operations. The second phase of the cost analysis is to compute the contractor's cost. There are three methods of obtaining an estimate of the contractor's cost: (1) informational quotations, (2) comparison with similar existing contracts, and (3) estimating.

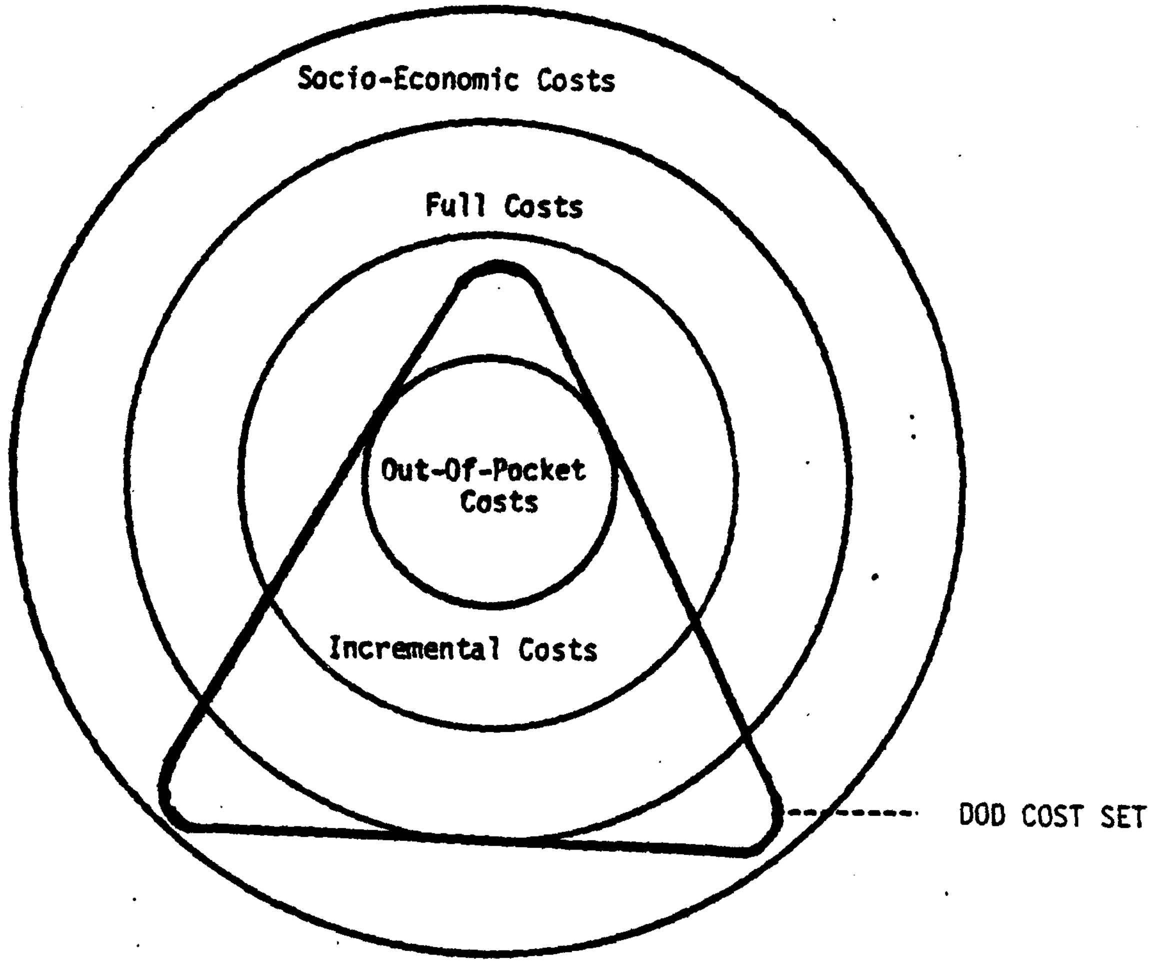
Informational quotations for cost comparison purposed have been used to obtain more than just the contractor's cost estimate. For example, if industry failed to respond to the request, the lack of a reponse was used as justification under exception 3 (not available from a commercial source) to perform the function in-house. If industry did respond, the Government could "back-into" the in-house estimate and thereby insure a lower in-house cost. The recent disallowance of informational quotations attempts to prevent both practices.[8]

Existing contracts similar enough for cost comparison purposes are rare. This leaves estimating by Government personnel as the only practical method of obtaining the contractor's cost estimate. It is difficult, if not impossible, for the Government to make an accurate, unbiased estimate of an imaginary contractor's costs. This in itself makes the entire CITA cost analysis suspect. Also, accurate cost data is usually not readily available to field personnel.

The many detailed shortcomings of the present DOD cost analysis method will not be addressed. Several activities are attempting to make improvements and provide additional cost analysis guidance for field activities. But what should such guidance be in order to insure

FIGURE 4

CITA COST ANALYSIS FACTORS



a fair and equitable cost analysis? In other words, what cost method should be used and what cost factors should be included?

"Fair and Equitable" Method?

The socio-economic cost method appears to be the most equitable method of comparing in-house and contractor performance; but because of the qualitative nature of the factors, it is impossible to conduct an accurate quantitative analysis at this level. Therefore, some other method must be used.

The full cost method is the next best alternative since it includes more pertinent cost factors than either the incremental or out-of-pocket methods, but full costing is also impracticable. There are too many unknowns and too many elements that cannot be fairly distributed over each function being analyzed. How can one equitably distribute the overhead costs of finance and accounting, personnel, legal, local procurement, police, fire, medical, library and other services, receipt, storage, and issues of supplies, and other general overhead? What is the fair share of the installation's overhead cost of management and administration of the group performing the function? What is a fair overhead allocation of higher level management? What is the real dollar value of the existing Government facilities and equipment used for that CITA? How much depreciation should be charged?

Almost as difficult to calculate are the direct costs of labor and materials. Material cost depends upon the accounting method chosen to value the inventory. Labor costs are dynamic and will vary with personnel turnover, promotions, cost-of-living increases, and reductions-in-force. What is the true cost of retirement or severance pay?

Any cost analysis that considers less than full costs in computing in-house cost is biased in favor of in-house performance because of that deficiency. Therefore, the out-of-pocket and incremental cost methods are not acceptable as fair and equitable methods.

After analyzing the overhead, labor, and material cost elements and the guidelines available for the CITA program, it is clear that true cost comparability cannot be achieved. Cost calculations are, at best, estimates and even reasonable estimates will not assure the desired degree of comparability. The current state-of-the-art in cost estimating, as applied to in-house versus contractor performance, allows unacceptably wide variations, primarily because cost analysis by its very nature is subjective as to which cost factors will be included or how much will be allocated.

There are many reasons for large cost estimating variations under the present or, in fact, any CITA guidelines. Substantial errors are inherent in any estimate that predicts future costs. Also, there are built-in biases whenever guidelines exclude certain cost factors from consideration. There are personal biases on the part of those preparing the analysis, especially when the individual is potentially affected by the outcome. In addition, there may be intentional manipulation of numbers to effect a desired result. And there is a general lack of qualified personnel to even attempt an analysis, just to name a few.

Variations will occur even when the analyses are reviewed or audited by an independent organization such as the GAO. The subjective CITA analyses are then reduced to debates between the preparing and auditing organization over whose judgment is best. Where jobs of Government or contractor personnel are at stake, these subjective variations are unacceptable.

A multitude of examples are available to illustrate the diverse results obtained from CITA cost analyses. The first of two of the more dramatic examples of divergent results allowed by the same set of cost analysis guidelines is as follows:

> A further problem with Circular A-76 cost comparison guidelines is the inconsistency of results which they permit.. A good illustration is found in the previously referenced 1965 DOD program to convert 10,000 contract spaces to Civil Service; five independent cost studies, using the same guidelines, produced widely divergent results.
>
> 1. The initial study by DOD, upon which the conversion decision was based, indicated a project cost savings of 16 percent.
>
> 2. A concurrent study by the Council of Defense and Space Industry Associations predicted increased costs of 20 percent.
>
> 3. In September 1966, the National Council of Technical Service Industries analyzed the costs of 599 converted technical employees, both domestic and overseas, and projected a total Government cost increase of 28 percent.
>
> 4. After the program was well underway (April 1967), DOD made a second study, which showed a savings of 8 percent.

5. The GAO made a study in September 1967, using a sample of 159 personnel converted at domestic locations, and estimated that savings from the DOD conversion program would be 15 percent.[9]

The second example illustrates variations in cost comparisons when they are prepared by the same organization. Four cost analyses were made, two in 1973 and two in 1974, comparing in-house versus contractor provided systems engineering and technical assistance services at the Army's Ballistic Missile Defense System Command at Huntsville, Alabama. The first two analyses revealed it was cheaper to perform the function in-house. The second two showed it was cheaper to contract for the services and resulted in reduction-in-force (RIF) actions. The American Federation of Government Employees (AFGE) brought a class action suit to prevent the RIF and was granted a preliminary injunction. In granting the injunction, a US district court ruled that the Army arbitrarily applied its regulations and observed that

> The court remains puzzled as to how a cost analysis, concluding that it would be approximately 30 percent cheaper in September 1973, could be so completely contradicted by two subsequent cost analyses performed some five and eleven months later showing a greater cost to perform the function 'in-house.'[10]

Many other routine cost analyses are also subject to question, but costs to police the system would be an added burden on an already expensive system and therefore prohibitive. Even if each cost analysis was thoroughly investigated, against what cost standard would acceptability be fairly judged? Out-of-pocket costs? Incremental costs? Full costs? Socio-economic costs?

After analyzing the cost factors involved and reviewing the state-of-the-art in cost analysis techniques, it is evident that true cost comparability is impracticable. Others have reached similar conclusions.

In a 1959 memorandum to the President, the Director of the Bureau of the Budget wrote:

> 1. The cost of Government operations are not comparable with the corresponding business costs. The Government, for example, pays no income taxes and operates its own tax-free facilities, thereby keeping costs down.
>
> 2. Government accounts are not kept in the same manner as business accounts, so that a comparison of the operation costs of Government versus business, for example, is not only difficult but often misleading.
>
> 3. Above all, the decision whether to continue or discontinue a Government activities solely on an apparent cost basis runs counter to our concept that the Government has ordinarily no right to compete in a private enterprise economy.[11]

A Department of Commerce study on OMB Circular A-76 stated:

> Under these guidelines it is clear that comparability cannot be achieved. The OMB Circular A-76 costing guidelines favor the in-house provision of goods and services and thereby subvert the Government's stated policy of relying on the private sector to provide its products and services.[12]

The Department of Commerce study further recommends eliminating Government cost analyses in situations where sufficient competition exists.

Summarizing the results of interviews with 27 Government agencies concerning the implementation of OMB Circular A-76, Study Group #1 of the Commission on Government Procurement stated:

> The most commonly criticized aspect was the degree of reliance on cost comparisons, which were considered by many to be of questionable value and validity. The use of incremental costing was strongly criticized by some of the individuals interviewed and as strongly supported by others. Perhaps one of the most useful comments on that issue came from NASA and the staff on the House Government Operations Committee, where extensive hearings were held on the subject--the questions of incremental vs. full-allocated costing simply can't be solved to the satisfaction of all.[13]

To be truly fair and equitable, the cost analysis method for comparing in-house versus contractor performance costs would develop into a system that would rival the Federal income tax system in expense and complexity. As a minimum, techniques would have to be developed (1) to fairly allocate all pertinent Government overhead costs, (2) to properly consider Government sunk costs where they exist, and (3) to obtain a realistic contractor bid or cost estimate. In addition, an effective policing and enforcement mechanism would be required to insure compliance with the complicated and reluctantly received guidance. This paper contends that scarce manpower resources should not be used on such an endeavor.

IV. EPILOGUE

The Government's policy of reliance on the private sector for its needed products and services is consistent with the free enterprise system. Recent trends toward increased reliance on the cost exception to justify in-house and contracting out decisions is costly. The wisdom of this trend and the ability of personnel to compare in-house and contract-out costs (apples and oranges) is questioned.

Another practice that parallels the increased use of cost comparison studies is presently being considered by the DOD. This is the practice of obtaining firm proposals from both the private and public sectors for CITA requirements. After proposals are adjusted to make in-house and contract-out proposals "comparable", the public or private sector offeror with the lowest adjusted cost proposal receives the award. This paper questions the comparability of in-house and contract-out costs and disagrees with the concept of competition between the private and public sectors.

Since OMB Circular A-76 states that it is Government's general policy to rely on the private sector, should Government compete with industry? If adequate competition exists within the private sector, the Government, according to ASPR principles, can evaluate competing private sector proposals and determine fair and reasonable prices. If proposals from the private sector are fair and reasonable, competition between the public and private sectors would seem to conflict with the Government's general policy of reliance on the private sector. If competition between the public and the private sectors were to become more widespread, the general policy statement of Government would not be to rely on the private sector for needed products and services, but to "obtain the needed products and services from the least costly public or private sector source." On the surface this statement may be praiseworthy, especially in today's economic climate. However, the inability to conduct truly comparable in-house and contract out cost analyses makes such a general policy statement ineffectual.

In order to more effectively implement OMB Circular A-76 several changes are proposed. First, it is recommended that in-house versus contract out cost comparisons be deemphasized. The cost comparability of the public and private sectors make such comparisons of questionable value except for aggregated, large dollar value functions. Secondly, to reduce administrative burden and cost, DOD's CITA Program should be redirected as follows.

a. For small dollar value functions and functions relatively difficult to administer under contract, allow the local installation commander to make the decision to make or buy without reporting or justifying either choice.

b. For medium dollar value functions and those that could be more reasonably administered contract for the requirement with no reporting or justification required if competition were available. In-house performance, justified for reasons other than cost, would still be reported.

c. For aggregated, large dollar value functions such as total installation operations and those with substantial sunk cost, encourage government-owned contractor-operated (GOCO) operation with the decision being made at major command level. In-house performance would continue to be reported.

Contract-out decisions are becoming increasingly popular in today's anti-big Government environment. All procurement professionals should be aware of implementation of OMB Circular A-76 and its potential impact on the procurement profession.

FOOTNOTES

[1]Helwig, Newlin, and Norton. Analysis of the Make-or-Buy Decision Criteria for Commercial/Industrial-Type Activities, APRO 518, Fort Lee, Va.: The Army Procurement Research Office. July 1976.

[2]DOD Instruction 4100.33 defines commercial or industrial activities as those 101 functional areas operated and managed by DOD components to provide products or services for Government use which are obtainable from private commercial sources.

[3]Army Regulation 235-5, Management of Resources Commercial and Industrial-Type Functions. November 1972, p. 4-1.

[4]Comptroller General Decisions B-175,703, dated 23 July 1973, and B-143,232, dated 15 December 1960, upheld use of out-of-pocket cost method under the Arsenal Statute.

[5]Study Group #1, Utilization of Resources. Commission on Government Procurement, Washington, DC 20006. January 1972, p. VII-119.

[6]OMB Circular A-76 Study. Bureau of Domestic Commerce, US Department of Commerce. January 4, 1972, p. 6.

[7]The example included in this paper is based on the costing method contained in Army Regulation 235-5. Other DOD implementation in this area (Sec Nav Instruction 4860.12A, Marine Corps Order 4860.12, AFR 26-12, and DSAR 4151.3) employ similar costing methods.

[8]Army Circular No. 715-2-27, Procurement Information. 27 June 1974, p. 1.

[9]Russell, William D. "Service Contracting-Boon or Boondoggle?" Paper submitted to the Command and General Staff School, Fort Leavenworth Kansas, January 24, 1975, pp. 24-25.

[10]American Federation of Government Employees vs. Calloway, US DC ND Ala, 6/18/75. Taken from Federal Contracts Reporter. Bureau of National Affairs, Inc., Washington, DC 20037. 7/21/75, p. A-16.

[11]Russell, op. cit., p. 24.

[12]OMB Circular A-76 Study. Bureau of Domestic Commerce, US Department of Commerce. January 4, 1972, p. 6.

[13]Study Group #1, Utilization of Resources. Commission on Government Procurement, Washington, DC 20006. January, 1972, p. VII-95.

Abbreviated Paper On:

PRODUCTION AND CONSTRUCTION

A comparison of concepts in shipbuilding and other industries

DR. F.A.P. FRISCH

Prepared for the 5th Annual DOD Procurement
Research Conference, November 17-18, 1976

Abbreivated Paper on:

PRODUCTION AND CONSTRUCTION
A Comparison of Concepts in
Shipbuilding and Other Industries

Dr. Franz A.P. Frisch
NAVSEA 075
U.S. DEPARTMENT OF THE NAVY
Washington, D.C. 20362
July 1976

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

The views expressed in this paper are the personal opinions of the author and are not necessarily the official views of the Department of Defense, of a military department, or of the author's present or past associates.

A definition is given of production and construction, and the general theory of production will be introduced. This provides a framework in which to place the related concepts of acquisition and management in relative prospective to the concept of manufacturing, and also in the context of its environment. Goals and philosophy as originated in the environment influence related concepts. Concepts are described and interactions delineated and outlined.

The Abbreviated Version

The un-abbreviated paper, although covering the essentials of the subject only, extends over 100 pages, 28 figures and 8 tables. In the interest of printing economy, an abbreviated version has been requested.

The original paper has been subdivided into two parts. Part I, called "AN OVERVIEW," discusses and explains in an editorialized form a wide range of interrelated problems pertaining to production and construction, and very specifically, to shipbuilding. Details are supressed to the utmost in the overview, but considerable weight is given to the philosophy of the 60's because of its motivating and leading force toward important decisions concerning the American shipbuilding industry in the 60's.

Part II, called "NOTES," is an ordered but not complete collection of detailed considerations dealing with the same subject as the overview. They will be of interest to various specialists in engineering, management science, and other disciplines. The notes support, explicitly or implicitly, the different sections of the overview, and some notes relate to more than one section.

Part I is self-contained, as is each individual note. The notes in Part II are additions to and detailed explanations of Part I but are more interesting than necessary for its understanding.

The present abbreviated version is based on Part I. No reference to Part II is made.

AN OVERVIEW . . .

. . . of, on, around, and about production and construction, with special emphasis on the American shipbuilding industry from the early 1960's until today.

- The overview deals with problems of production and construction, especially as related to the American shipbuilding industry in the widest practical context.

- The overview must be interdisciplinary. It addresses explicitly and implicitly legal aspects, engineering aspects, and aspects of economy, which may be summarized in the author's pet acronym LEGENOMY.

- The overview also attempts to trace the facts of actions, of results, and, foremost, of decisions back to their intellectual roots in philosophy.

- The overview is written in a rather general and editorialized form in order to foster "the understanding" of problems in production, construction, acquisition, and similar operations by a forum representing many disciplines. Details are relegated to the notes at the end of the original unabbreviated paper. To understand the problem one does not have to be a specialist in any particular field. All that is necessary "to understand" is the command of logic in the form of horsesence and the willingness to think somewhat beyond the surface.

- The most intriguing part of the overview may be the recognition that facts explain very little, but many things can be understood in the search for the underlying and motivating philosophy. This, at least, will be what the author tries to underscore.

- The overview is subdivided into six sections and begins with a definition of the terms production and construction (Section 1), and tries to place these activities in the framework of the total acquisition system (Section 2). As the next step, an attempt is made to sketch some of the motivating forces which make the system "tick" (Section 3), and of what may have gone wrong with the system in the last decade (Section 4). A discussion of labor problems follows (Section 5), and finally, many differences between production and construction are illustrated by the use of concrete examples (Section 6) leading to conclusions.

- The overview, like the paper as a whole, is a search for concepts. Some concepts are firmly formalized, others are just drafted, and some may be provocative and may lead to lively discussion. But hopefully, none of these concepts are dull.

- No attempt has been made to dogmatize, to write a text or a cook-book of "how to do" things. Those who desire a cook-book may stop reading here in order to save time adn to avoid disappointments.

• The overview refers to many concepts of general systems theory, economics, epistemology, philosophy, and other disciplines. Many of these references could expand into several lectures and will be dealt with in a forthcoming book by the author under the title A General Theory of Production and Construction. The author hopes, however, that the present brevity of treatment will not detract from acquiring the flavor or tenor of the problems at hand.

1. DEFINITION OF PRODUCTION AND CONSTRUCTION

Many differences between production and construction are discussed in this paper. The appreciation of these differences is fundamental for the determination of research needs and their relevance to procurement and acquisition strategy, because the "modus operandi" of procurement and the specifics of each manufactured item are interacting parts of a single system, with strong feedback from the specifics of each manufactured item to its related management system and control possibility of the manufacturing process.

There are two ways to view production and construction. First, production and construction can be considered as the two concrete branches of manufacturing, with production implying multiple operations as in automobile production, and with construction implying one-of-a-kind activities as in bridge construction or ship construction. Second, production and construction can be considered as two abstract concepts at the furthest bound and outside all manufacturing processes.

Both views of production and construction, the concrete and the abstract, have shortcomings and values and will, therefore, be used selectively in this paper.

The concrete view of production and construction considers both as the two areas or branches of manufacturing. These areas are overlapping and a clear demarcation between the two branches may not exist. Reference to a specific manufacturing operation as being either production or construction remains highly subjective. The criteria of the concrete view will be exemplified by selected manufactured goods rather than exactly defined. The fluidity of a concrete comprehension of production and construction has some similarity to that of the terms strategy and tactics, where the differences are undoubtedly acknowledge but are evasive to firm formulation.

Treatment of the concrete view of production and construction within the present paper will be geared to consideration of the manufacturing process for a precision product (watches), a fairly complex mass-produced item (automobiles), and construction product (ships).

The abstract view of production and construction defines Production and construction as two independent, abstract concepts. The two concepts are the boundaries of all manufacturing processes, but neither concept will be achievable in purity. All actual manufacturing processes will be distributed within the boundaries and tend toward either production or construction. A change in distribution and a skewing from construction toward production in the history of industrial development can be successfully argued, but at this time it can be neither quantified nor pinpointed with exactitude.

In the abstract, production is associated with an infinitely repetitive operation, where all decisions with regard to the process are made before the process begins. The abstract concept of construction is associated with a single, non-repetitive operation, where all decisions beyond setting the original goal are made during the operation. This in turn connects production with a horizontal linear management structure and the related decision process with a conference mode; in contrast, construction will be related to a vertical, hierarchical management structure with the decision process relegated to the lowest possible echelon in the hierarchy, as is typical in a dynamic mode. No ambiguity exists between the two concepts of production and construction, and both can be discussed with great clarity. It must only be remembered that the abstract concepts of production and construction are a paradigm, modeling the process of manufacturing at its extremes.

2. THE SYSTEM OF ACQUISITION

Starting out with two platitudes, the system of acquisition will be readily seen: first, nothing can be acquired which does not exist or which cannot be brought into existence; second, nothing will be acquired without a specific reason, valid or otherwise. Hence, the system: Product-Acquisition - (goal-setting) Environment. This covers in three words the entire gamut of all industrial activities.

More specifically, the process of manufacturing -- and therefore, of production and construction -- is at the center of any industrial operation in an industrialized society. The activity of manufacturing is the Inner System of the industrial operation. The Outer System contains all elements which surround the Inner System and connect the Inner System with its Environment. The Outer System contains the legal-political elements and also other such as contracting, procurement, and acquisition. The Environment is formed by the elements of national and international economy, national goals, socio-political trends, axioms, and last but not least, the opinion-forming philosophy time.

The structure of neither the inner system, the outer system, nor of the environment can be understood in isolation. Interdependency and feedback exist among all three structures and also among the elements within each structure. The behavior among the elements of each structure can be characterized by either harmony or stress, and the behavior among the structures by either compatibility or incompatibility.

The total system made up of the three structures and their elements is sketched in Fig. 1. The sketch places the central topic of this paper, namely the inner structure and its relationship to the outer structure, in the perspective of the total system. Even this restructed scope may be almost too much for a single paper. Definitely, everything beyond this scope must be neglected; even important theoretical system considerations must be omitted. Only one exception must be made because it is considered to be of utmost importance: the causative philosophy leading to the present problems in the American shipbuilding industry.

3. THE TEAM PHILOSOPHY OF THE 60'S

Most professionals of the physical, engineering, and legal sciences abhor philosophy. They prefer hard facts and measurable quantities. Facts, however, are only the visible ends of decisions, and seldom are they able to explain nondeterministic causes. Decisions can often only be explained by a search for the motivating and underlying philosophies. Even such apparently realistic facts as the change in management thinking of the 60's and the forceful introduction of improvement action into the American shipbuilding industry have deeply rooted philosophical causes. These causes must be clarified in order to understand the resulting trends in implementation.

The constellation of world politics in the early 60's indicated the possible need for a strengthened American shipbuilding industry, and a search for shipyard improvements began. The result of this search was a generally accepted but never officially decreed strategy, combined with a series of specific tactical measures.

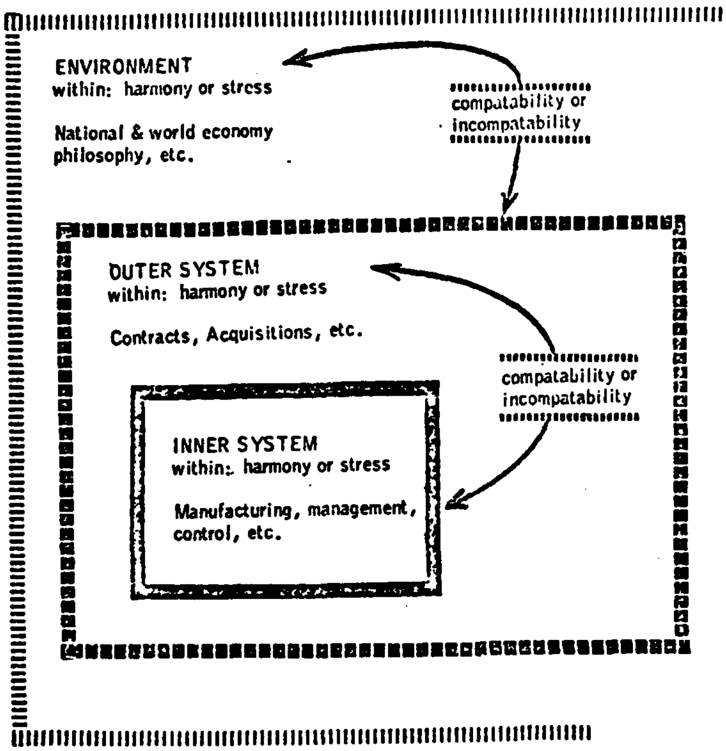


Fig. 1 The System of Acquisition

The strategy for shipyard improvement had two principal parts: (1) a transfusion of management techniques and production knowledge from the aircraft industry into shipbuilding, and (2) a broadening of the financial base for the shipbuilding industry by incorporating shipyard after shipyard into large conglomerates. Some of the tactical elements of the shipyard improvements of the 60's were: (1) revised contracting techniques, (2) increasingly detailed requirements for bidding documentation, (3) more and more detailed specifications, (4) increased control of contract performance, and (5) increased substitution of capital for skilled labor.

The two elements of strategic improvement listed above and the five technical improvements suggest five causative propositions for today's predicament in the American shipbuilding industry as far as Navy contracts are concerned: (1) bad strategy, (2) numerous tactical errors in executing the strategy, including exerting insufficient effort, (3) incompatibility between strategy and tactics, (4) incompatibility between the object of production and strategy and/or tactics, or (5) any combination of the first four causes.

Even before making an initial judgment about the five causative factors above, the elements of strategy and tactics must be recalled, and it should be noted that all elements were immensely compatible with each other. They appear to be the outgrowth of a very specific underlying philosophy which, unfortunately, has never been spelled out in a concrete and formal manner. All of its aspects, however, are discussed in an abundance of other wise uncoordinated papers. The most coherent picture of this philosophy can be deducted from the actions of its principal proponents and disciples in Government, industry and academia. The "philosophy of the 60's" has never even been named, but for reference purposes in the present paper the term "team philosophy" is suggested, because many contributors can be determined but no actual inventor.

The "team philosophy" was not the brainchile of any one towering philosopher, but rather the product of inbreeding of parochial interests in politics, business, and academia. The "team philosophy" borrowedits three key propositions from three philosophical concepts which are related to each other, positivism, materialism, and rationalism. This resulted in the claims: (1) that everything which cannot be rationally understood should be ignored; (2) that all material aspeects can be calculated and therefore can be optimized; and (3) that a unique rationality in solutions and in behavior exists and, therefore, a rational prediction of the future is possible.

The team philosophy corresponded to the corporate concept of conglomerates. It justified (1) the combination of functionally unrelated divisions into a single economic organization and (2) the imposition of a uniform control and management system on all the organization's divisions. In turn, it justified a highly centralized command posture for the corporate headquarters.

The team philosophy also corresponded quite well to the leading economic theories of its time, when it was assumed that any industrial activity can be expressed in a production function and can be described adequately by an econometric input-output model with an almost standardized structure.

The team philosophy corresponded, too, to claims of the leading and most vocal systems theorists, who proclaimed that they had found the ultimate and uniform technique for computer modeling of all industrial, urban, and even worldwide problems and behavior patterns.

The team philosophy in its total has not added a single new thought to the already existing body of formal philosophical knowledge; it was -- or rather -- a passing current when judged by any standard of originality. But the representatives of the team philosophy were a most active force in transforming the "spirit of the times" into operational concepts. The most unique features of the team philosophy may be (1) the absence of a responsible author and (2) the even distribution of the price for its consequences to all.

A detailed study of the team philosophy may be most enlightening. The foregoing sketch may be just enough to give food for thought.

4. RETURN TO PRAGMATISM

Wisdom and hindsight go well together. Years ago, when (1) the process of knowledge transfusion from other industries into the shipbuilding industry began and (2) the financial base for the shipyards was being strengthened by conglomerates, nobody had either the willingness or the foresignt to object. The innovators' optimism carried the Government, the industry, academia, the politicians, and the investors along, and the few antagonists were not able to present their case with logic and analysis. So the largest experiment in the modern history of the American shipbuilding industry began -- except that no one had the foresign to call in an experiment.

Today, some results of the team philosophy present themselves in both delays in shipbuilding programs and large claims, and a return to pragmatism may be advisable. Pragmatism is the American-born philosophy which suggests measuring the value of a concept by its results in application. Pragmatism may be less sophisticated than the foreign sources from which the team philosophy borrowed, but it also lacks the decadence of the latter.

In accordance with pragmatism, the strategy and tactics imposed upon the shipbuilding industry during the last decade can be analyzed; but this should not be done in a serach for a culprit for the collective sins, but rather in order to avoid repeating errors of the past and to gain a new view toward the future.

Looking back, it appears that most innovations introduced into the shipbuilding industry during the last decade were somehow related to management. This justifies the introduction of the term "management density." The term "management density" suggests the possibility of summarizing many different management actions in a quantifiable model with dimensions such as (a) numbers of reports and pages on management information per ton of ship; (b) pages of specifications per ton of ship; (c) pages of bidding documents per ton of ship; and (d) pages of contract documentation per ton of ship.

Looking back, it may be justified to introduce the term "goal departure." The term "goal departure" suggests the possibility of a quantitative summation of the results of the industrial experiment in shipbuilding such as (a) the delay in delivery of ships; (b) the number of change orders per ship; and (c) the amount of claims per ship. "Goal departure" may be a measurement of how far the result has departed from the planned goal.

Assuming that both of the terms management density and goal departure can be sharply defined and dimensionally quantified, then the ratio of goal departure to management density can be used to measure the effectiveness of management in both physical and cost terms. In the most simple language, it is suggested that a comparison be made of the results of innovations with the efforts related to them, or that a measurement of the cost of results or effects against the cost of causes be made. To illustrate this concept, let's list a few general observations (without attempting quantification) most relevant to the present situation in the American shipbuilding industry: (a) The management information flow has increased significantly over the last decade, while the management of some shipbuilding programs has seemed to collapse. (b) The number of change orders seems to increase with each added detailing effort of the specifications. And (c) the bidding documentation has increased from pages to books per ton of ship, while claims have skyrocketed.

These observations suggest the existence of and ordered relationship between inputs in the form of management density and outputs in the form of goal departure. This relationship seems to be quite different from what is commonly assumed, which is, that more and more management is associated with better and better results; the decrease in goal departure with increased management density would seem in doubt. It appears, that rather an optimal and product-dependent management density would exist for zero goal departure. In more practical terms, it seems that (1) undermanagement and overmanagement will result in goal departure, and that (2) each individual manufactured item has its own optimal management density according to its tendency toward production and/or construction. This thought is illustrated in Fig. 2.

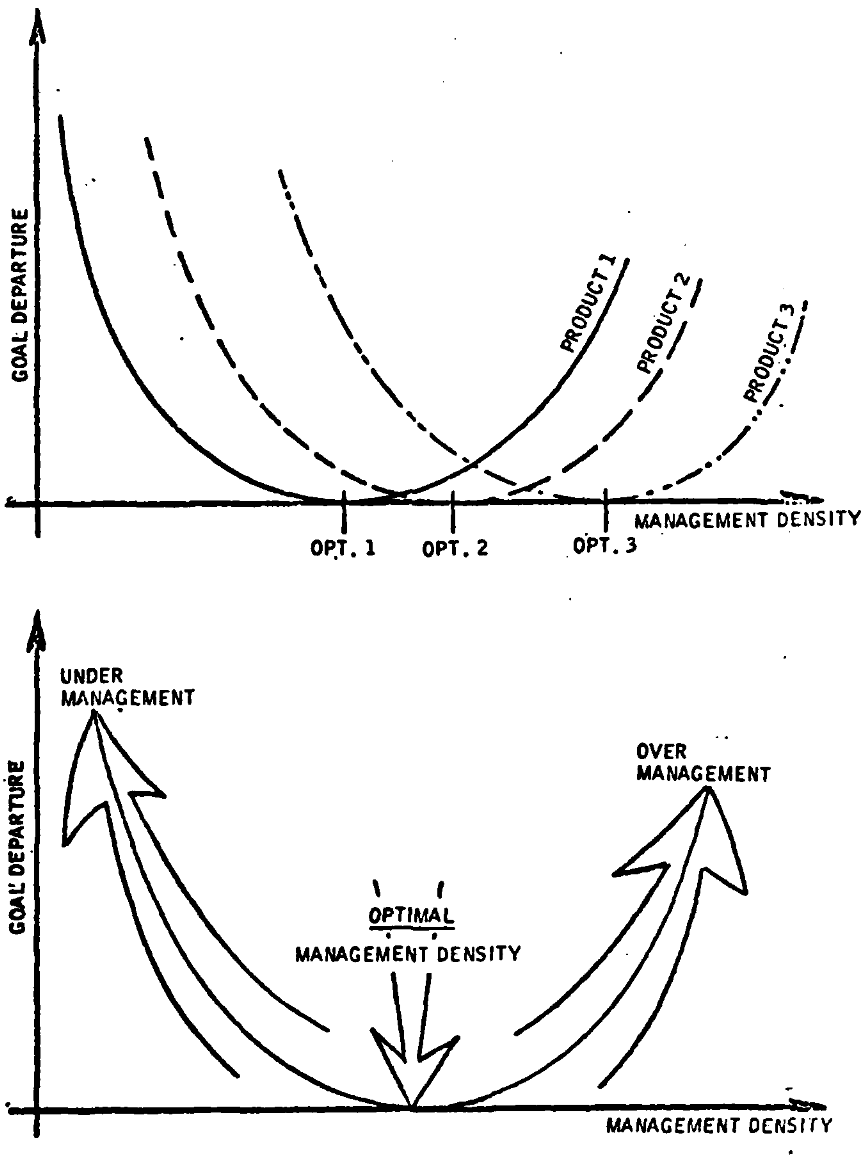


Fig. 2 Management Density versus Goal Departure

The new concept of goal departure and management density is a pragmatic proposition based upon the author's expeerience. At the present time the new concept is a verbal model in terms of general systems theory. It has all the shortcomings of a nonmathematical model but expresses some previously unnoticed aspects in hopes of future development of a suitable algorithm. Furthermore, the concept is only broadly sketched in this paper. But even the sketch should suffice to (a) close the loop of understanding between philosophy and reality, (b) separate opinions from facts, and (c) open new perspectives for research as well as options and solutions for the future of the American shipbuilding industry.

5. THE LABOR FORCE

In the search to place the different elements of rpoduction and construction into proper relationship, an overview would be incomplete without at least some consideration of labor-related problems. More specifically, but highly simplified, the product, the production method, the training level of the work force, and the management density are firmly interrelated elements, as depicted in Fig. 3, called "the Production Circle."

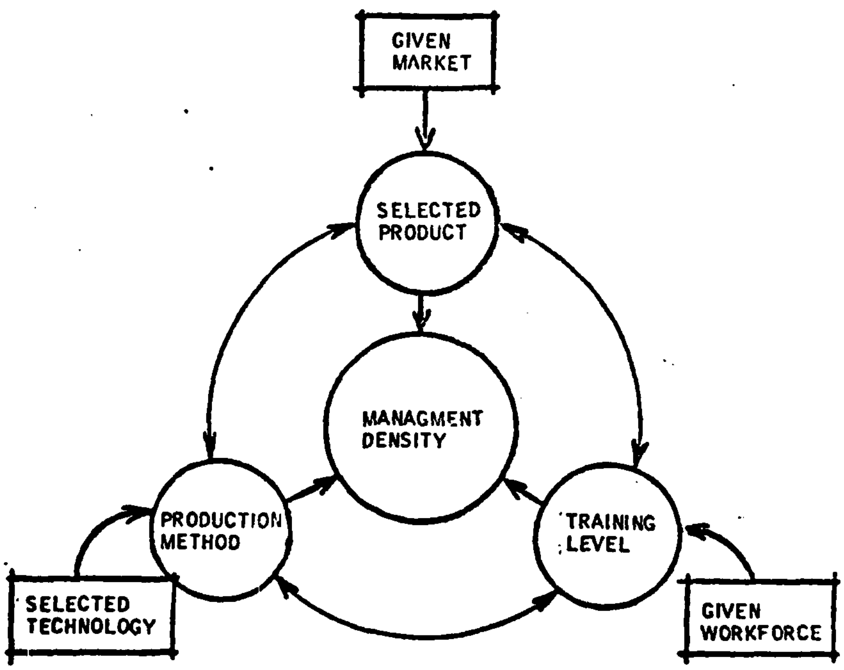


Fig. 3 The Production Circle

The outer ring of the production circle is formed by the product, the production method, and the training level of the work force. In the center of the circle is the management density. The product will be blended into the market, and the market tells the product how many pieces may be sold and, therefore, how many may be produced. Of course, the product can influence the market, but the pragmatic industrial planner will prefer to accept the existing opinion of the market as a given input rather than try to influence the market and risk bankruptcy; the creation of a new market through a prdouct is a most dubious beginning. The production method chosen for the product will be selected from the common pool of technological knowledge and willbe related to the training level of the available work force. The training level of the work force may be influenced by in-house or on-the-job training; however, it its totality it will also be an input to production or construction. The product, the training level, and the production method work toward the center in selecting the appropriate management density.

For the sake of argument, let's assume that the abstract concept of production can be made into a reality, and that therefore, the number of pieces to be produced is unlimited. Such an operation can then either be fully automated with no workers at all, or the total operation can be subdivided into sufficiently small work packages to permit the utmost woker specialization and, hence, the employment of entirely untrained workers. The management density will be great and planning prior to the start of the operation must be detailed up to the point where each individual hand movement of the worker will be preplanned, measured, and pre-prescribed. This form of production is expected to be capital intensive.

Next, let's go to the other extreme and assume that the abstract concept of construction can be transformed into a reality; only one single and unique piece of manufactured merchandise is to be constructed. Most naturally, the planner of such an operation will search for the minimum capital investment, the lowest possible management density, and foremost, for the employment of industrial master artisans. And here the dilemma begins, because the availability of master artisans in an existing labor pool is a given, and not a selective, input to the industrial process. Therefore, capital must be invested and work packages detailed downward to the level of comprehension of and by the existing artisan level of the work force, which in turn dictates the necessary minimum of management density.

The circle is closed and the dilemma delineated; only it goes much furhter than already indicated. The realist will accept the fact of the given work force. But then comes the management scientist with an earnest attempt to quantify skill levels with precision. Along comes the economist in his search to replace skilled workers with a combination of unskilled workers plus capital, which was the advertised goal of some "improved shipyards" in the 60's.

Intellectually, there is nothing wrong with the desires of management scientists and economists. Only the presupposed necessary knowledge to respond to those desires does not exist in reality. Social and behavioral sciences are still, and may have to remain, dialectical disciplines, far removed from a mathematical comprehension of key issues. This causes discomfort in model builders and similar breeds because a work force which is not reducible to a statistical formula has no manipulative input value, and the known algorithm must either bend reality to suit the formula or restrict the field of vision to small parts of reality.

The practical implications of this train of thought are formidable. First, absolutely no basis for judgment exists to determine if the advertised goal of one specific shipyard, namely to replace skilled workers with capital plus unskilled workers, has been reached or not, because at best a vague and subjective notion exists of the meaning of "skilled" and "unskilled;" wage levels are too defused by other formative determinants to be meaningful. Second, even infinitely more important is the recognition that it may well be that the national options in America in selecting the most appropriate methods for ship construction are restricted because of the available training levels. This in turn gives only two extreme alternatives, either: (1) to construct ships in less than the optimal manner because of the dictates of the training level of the work force, or (2) not to do it at all.

Perhaps the direction of some of the improvement efforts in the 60's was not wrong after all. Perhaps the right things were tried but for the wrong reasons, and with ill-defined means. How to find out? How can a transition be made from the present emotionally charged but otherwise idle and empty discussions about labor skill, labor deterioration, and what not, toward a meaningful scientific plateau?

The sine qua non, the absolutely mandatory prerequisite to bring meaning into the discussion of skill levels, the determination of worker efficiency, the vagueness of learning theory, the supposed trade-off between capital and skill, and similar subjects would be the development of a labor taxonomy with tremendous refinement.

The taxonomy must go into the classification of trades down to the most detailed subfunction in each trade, the mapping of skill-transferabilities between trades, and many other details.

The result of such a taxonomy-search would be a library of standards for time allotment from the most detailed task, such as emptying a trash can containing three cubic feet of paper and with a unit weight of seven pounds in an unairconditioned room with a 95-degree ambient, up to the hours permitted to conduct a stability calculation for a ship with 250 feet of length, and so forth. In reverse, all workers through all levels can be classed according to the slots they can fill in the taxonomy. Even incentives can be built into such a taxonomy; it would only be necessary to pay according to the fulfillment of taxonometric tasks, which was called in construction, years ago in simpler times, wages by piecework. Taxonomy for production has only planning value.

Such a taxonomy would be most decorative to the mental furniture of the team philosophy. Such a taxonomy is the centerpiece for a computerized resource distribution and for the perfect study of trade-off between capital and skill. The taxonomy contains all elements needed to fully optimize, rationalize, and control industrial behavior, with one exception: human values.

With this the discussion has returned to philosophy. And there scientific neutrality ends.

6. SUMMARY AND CONCLUSIONS

(A qualitative comparison of three industries)

The foregoing five sections should have made it clear that (1) no universal panacea can exist for any problem, and that (2) the notion of scientific objectivity and neutrality is most naive and misleading. More specifically, some central messages should recognizable:

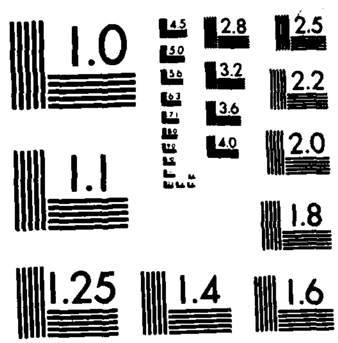
- The process of manufacturing is NOT homogeneous but has unlimited diversity. Therefore:

  A. NO SINGLE CONCEPT OF MANUFACTURING CAN FIT ALL GOODS; THE CONCEPTS VARY BETWEEN PRODUCTION AND CONSTRUCTION.

- The selection of a particular process depends upon many determinants which are themselves variable in time and in place, and the management system must deal with all these variables. Therefore:

AD-A128 657 THE ANNUAL DEPARTMENT OF DEFENSE PROCUREMENT RESEARCH SYMPOSIUM (5TH) HELD 17-19 NOV 76 MONTEREY CALIFORNIA (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA NOV 76 7/7

UNCLASSIFIED F/G 15/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

B. NO UNIFORM MANAGEMENT SYSTEM CAN EXIST WHICH CAN BE SUCCESSFULLY IMPOSED UPON ALL PROCESSES AT ALL TIMES AND UNDER ALL CONDITIONS.

• The technology of manufacturing, the management of the process, the economy and the acquisition methods, the training level of the work force, the philosophical motivatiins, and many other elements are all part of ONE system. Therefore:

C. TO SINGLE OUT A SPECIFIC DETAIL FOR SPECIAL RESEARCH MAKES SENSE ONLY IF THE PLACE OF THIS DETAIL WITHIN THE TOTAL IS WELL RECOGNIZED.

• Facts, decisions, and philosophy form a never-ending, vicious circle: facts are the result of decisions; without decisions nothing every happens. Decisions, in turn, are based upon the interpretation of facts and the interpretation, finally, upon philosophy. Therefore:

D. ULTIMATELY, ANY DECISION IS AN EXPRESSION OF A PHILOSOPHY. IN REVERSE, ONLY THE UNDERSTANDING OF PHILOSOPHY LEADS TO THE UNDERSTANDING OF DECISIONS AND THE SPECIFIC INTERPRETATION OF FACTS.

The author is fully aware that the above central messages, A, B, C, and D, are very broad generalizations. The author also expects that many readers will consider the four messages as most trivial "motherhood and sin" statements. The author would agree that this criticism, and he even adds that such statements should not be necessary in the first place. But most unfortunately, they are necessary because all too often a beautiful, scientific, formalistic superstructure detracts our attention from the less perfect foundation. Just one "for instance:" the learning curve. Books and papers exist in abundance which deal with its mathematical treatment. Statisticians have a field day with fitting curves to the dots of past events. But nobody really knows what industrial learning is and what factors contribute to variations in the learning phenomenon. Nobody really knows the basic fundamentals of industrial learning. Does "learning" rest in the worker, in middle management, or in top management? Or how does each share? Is learning a function of the organizational structure? All this is unknown and speculations change from specialist to specialist. Nobody understands the relationship between the past experience and the future behavior of the phenemenon -- with the exception of very general principles. Nevertheless, we project absolute uncertainties into the future with great exactitude, and we are utterly upset if this future never happens. Delivery delays and cost overruns in shipbuilding are a point in case, where almost as a rule the expected learning never materialized.

This author's observation indicates that errors are very seldom made in the intellectual superstructure, but most frequently in the fundamentals. For example, an erroneous mathematical treatment of an algorithm almost never happens; but few algorithms exist which fundamentally approach reality to a useful degree. This is the reason why this author puts so much emphasis on fundamentals instead of indulging in the beauty of the superstructure.

To underscore the fundamentals, a few concrete examples of different industries will be outlined. To permit a rapid shift from abstract to concrete considerations, three industries have been selected for illustrative purposes: (1) the watchmaking industry, (2) the automotive industry, and (3) the shipbuilding industry. The first two industries are representative of production and the last of construction. The comparison of the three industries is selectively summarized in Table I and a few items discussed as follows:

Items:
- Manhours per unit
- Building time per unit
- Number of components

It is justifiable to assume that an operation with more than one million nonrepetitive-task manhours can necer be planned with the same precision as an operation with a few hundred (repetitive-task) manhours. It is absolutely possible to calculate the last detail for a production line, but not for a multi-year operation.

Items:
- Changes during production
- Experimentation during production
- Trial run for production

It is standard procedure in mass production to build a series of production models and test those models for producibility and other aspects. As soon as the decision to produce is made, a trial run begins in order to "debug" the system prior to production. In construction, especially in ship construction, the model is the product and everything which cannot be predetermined with paper studies must be tried out during production in the form of rework, change orders, or something else.

Items:
- Risk prediction
- Predictability of problems
- Task variations

In production all risks for the manufacturing process can be predicted because the technical risks are only within the statistical limits of the production line; preventive maintenance of tools, variations in material quality, and so forth are all within

TABLE I
COMPARISON OF INDUSTRIES

	QUALITATIVE INDICATOR FOR:		
	PRODUCTION INDUSTRY		CONSTRUCTION
ITEM	WATCHMAKING	AUTOMOTIVE	SHIPBUILDING
Capital/labor	Capital intensive	Capital intensive	Labor intensive
Man-hours per unit produced	Below 1 hour	The low 100's	Million range
Weight per unit	Very low	Low/high	Very high
Building time per unit	In hours	Hours to days	Measured in years
Units produced	Very high	Very high	Often 1 of a kind
Complexity	Precision, high	Mixed, high	All ranges
Number of components	Below 100	In the 1,000's	In the 100,000's
Market	Free market	Free market	Monopoly (USA)
Planning before production	Complete	Complete	Targets only
Decisions during production	None	None	Permanent, many
Management organization	Linear	Linear	Hierarchical
Changes during production	None	None	Many
Experimentation during production	None	None	Some
Predictability of problems	Full	Full	Limited
Risk prediction	Possible	Possible	Not possible
Master plan for production	Calculated	Calculated	Estimated
Trial run for production	Standard procedure	Standard procedure	Not possible
Skill requirement	Low	Low/medium	Mixed/high
Learning during production	None	Very little	Considerable
Task variation	None	None	Large
Repair aspects	Total replacement	Component replacement	Repair
Lifetime of unit	Some years	About 7-10 years	Up to 30 years
Modernization during lifetime	Never	Almost never	Frequent
Work density	Calculated/constant	Calculated/constant	Estimated/variable
Contracting	Rigid	Rigid	Flexible
Progress control	Measurable	Measurable	Judgment
Production control	Simple	Simple	Complex

the knowledge and within the control of the producer. In construction, many problems cannot be foreseen. For example, a subcontractor may not be able to deliver; new weapon developments must be accommodated; weather in open building areas influences worker efficiency; once delays occur they may be compensated for by overtime; tasks may be revised because of necessary planning changes and revisions on other time-related activities. All together, problems and risks in production are practically eliminated, while many are not even foreseeable in construction.

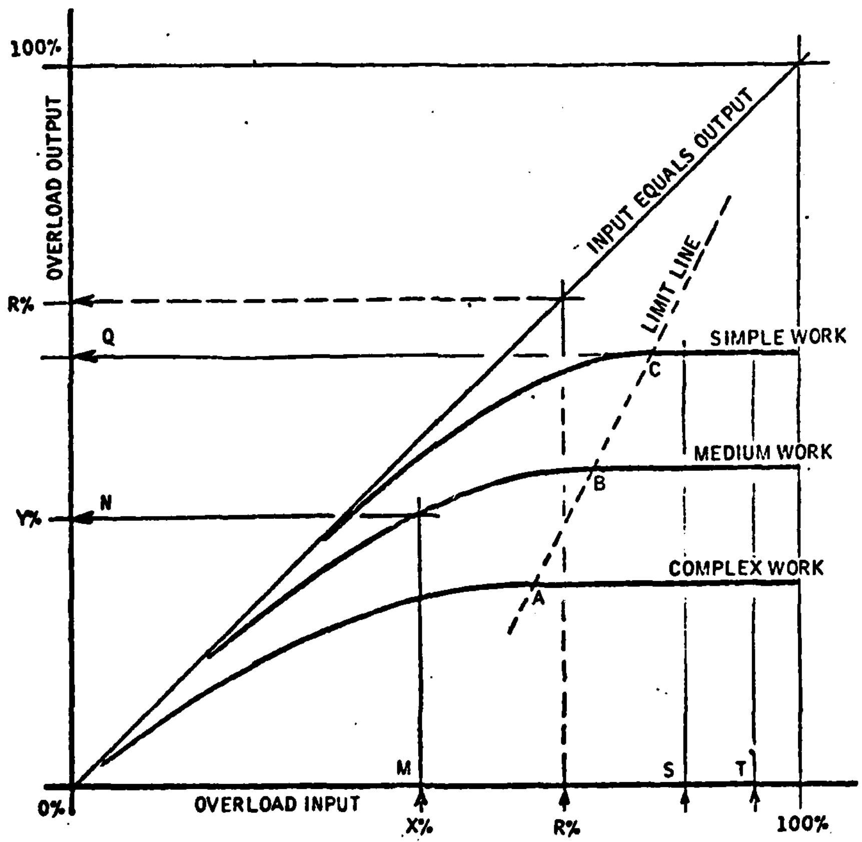


Fig. 4 Work Density and Loss (At Overload Condition)

Item: • Work density

The problem of work density is unknown in production but is crucial in construction. For example, the question of how many electricians and/or how many plumbers can work in a confined compartment or room at the same time without mutual interference represents a problem of work density. The determination of work density is a part of the planning for any construction job. Such planning is, of course, based upon experience, but it is at best an estimate and not an exact calculation. The problem of overload -- how many more people can be assigned to a specific task in a specific area in order to seped up the construction -- is related to work density. This problem is illustrated in Fig. 4. The graphs in this figure have been suggested by the author in order to deal with specific problems in production analysis; the graphs are supported by logic and by the concensus of many colleagues -- but with present-day knowledge no firm formulation can be given.

Item: • Management organization

Construction has a large number of uncertainties which are unknown in production. Many of these uncertainties are go/no-go propositions and are not within a statistical error distribution. To assign probabilities to many uncertainties along a critical path is not possible. The insertion of time buffers for unforeseeable events is problematic, because such events and their location in the PERT chart are ipso facto unpredictable (otherwise they would not be called unforeseen). All together, this means that management of a construction operation, if a ship for example, is a permanent decision process of permanent adaptation to new situations, and a permanent improvisation toward the predetermined goal. Construction management is a permanent tactical operation where decisions must be made in real time and often at the platoon and company level; decisions cannot be pushed up the ladder to the battalion, the regiment, or the division level. The management of construction must be flexible and cannot be hindered in its tactical decisions by rigid control planning from the top down. Rigid management is appropriate only for production. Recognizing this fundamental difference, questioning the suitability of management tools as developed in mass production to construction is legitimate.

Items: • Production control
• Contracting
• Progress control

Neither of the three items above poses a problem beyond the routine for production goods. But all three items pose considerable problems in construction. The control of construction cannot be too rigid, and progress is often not precisely measurable without an absolutely detailed baseline for departure. The contract, on the other hand, is the mirror image of risk, predictability, measurability, and other vaguely determinable elements. The prudent buyer will try to cover all these unknowns in his contract. If the seller has to take all the risks alone, the price may have to be exhorbitant; this is often impossible for competitive reasons. If the buyer is willing to share the risks, he never knows what he is really buying. A flexible contract does not permit sound budgeting on the part of the buyer, and a rigid contract does not permit the necessary flexible planning on the part of the seller. Such problems are almost unknown in production, but they are typical in construction and are often the cause of a considerable dilemma.

Some of the differences between production and construction have been listed in Table I, and some of these items have been discussed briefly. But even these few samples should suffice to convince the reader of the significant differences between production and construction with regard to management, contracting, and control. To sum it up:

> PRODUCTION AND CONSTRUCTION EACH HAVE THEIR OWN INTERNAL OPERATIINAL LAWS. TRANSFUSION OF EXPERIENCE FROM PRODUCTION INTO CONSTRUCTION, OR VICE VERSA, WILL BE DETRIMENTAL TO EITHER OPERATION. MANAGEMENT OF CONSTRUCTION NEEDS COMPETENCE IN MANAGEMENT AND IN THE SPECIFIC AREA OF CONSTRUCTION; MANAGEMENT OF PRODUCTION NEEDS COMPETENCE IN MANAGEMENT ALONE.

For clarity: this picture is fairly much black and white. Reality, however, is not a neither-nor proposition, but exists in many shades of gray, which makes the issue even more complicated.

7. RESEARCH TOPICS

One of the author's tacit objectives is the closing of the communications gap between the practitioner of shipbuilding, management and contracting and the scientific specialist who may be interested in only one or the other aspect of shipbuilding, management, and contracting.

The best way to build this bridge between the practitioner and the scientist may be to outline some research topics. Each of the research topics listed is of utmost importance to the practitioner in its possible application; however, the solution for each topic is in the domain of scientific specialists:

Some of the research topics are:

- Job criteria and Character Criteria of the Work Force:
  Establish the relationship between the character tendencies of a work force and the criteria of the preferred type of work.

- Character of Labor Force and Form of Management:
  Determine the form of management suitable to provide the most incentives to a specific work force.

- Piece Wages in Production and Construction:
  Determine managerial prerequisites and technological limitations of piece wages as an incentive.

- Flexibility in Construction and Production:
  A statistical study of variations between plan and results in different fields of production and construction.

- Decision Process in Construction and Production:
  Analyze the dominant mode for the decision process, its real-time requirement, and the completeness of the information base.

- Labor Taxonomy:
  Determine need, users, and resolution level for the development of a labor taxonomy.

- Prototypes, Trial Runs, and Production:
  Develop statistics on time and cost for prototypes and trail runs in production, measured against the production run.

- Risk and Profit in Construction:
  Statistical study across many construction industries in order to establish the relationships between prevailing risks and profits.

- Management Structures and Corporations:
  Search for the prevailing relationships between organizational structure and type of product, size of company, and profitability.

- Industrial Escalation:
  Different forms of escalation clauses are used. Establish relationships among clauses, products, and economic determinants. World-wide study.

- True and False Competition:
  Determine economic conditions justifying either proper competition or proper sole-source procurement.

- The Retroactive Forecast:
  Develop a standard procedure for the verification of forecasts and forecast models.

CONTROL OF MAJOR CHANGES TO AND RESULTANT COST GROWTH IN WEAPON SYSTEMS ACQUISITION CONTRACTS

by

CDR Arthur C. Meiners, Jr. (SC) USN

This paper is a report of the results of a year's research into the causes and control of major changes in weapon system accuisition contracts. Although all types of weapon systems were studied, most findings and recommendations relate directly to the acquisition of U.S..Navy ships.

The research was performed as part of the author's doctoral program at The George Washington University.

The research approach used was to query the change principals involved in weapon system acquisition: the DOD Project/Program Managers, the Contractors' Program Managers and the Procuring and Administrative Contracting Officers. It was felt that since these individuals handled all major changes, they could best provide the empirical information concerning the nature and genesis of these changes. The data collection approach consisted of sending pre-tested questionaires to the change principals of twenty-two weapon systems and interviewing the change principals from one system selected from each service. Secondary research was conducted utilizing the Library of Congress, the library of the Commission on Government Procurement, libraries of universities in the Washington, D.C. area, and the facilities of the Defense Systems Management School at Fort Belvoir, Virginia.

In background, a review of the literature revealed that very little had been written about changes to weapon acquisition contracts. The first comprehensive study on the weapon system accuisition process was performed by

Merton Peck and Frederic Scherer in 1962 at the Harvard Business School. They concluded that the most significant causes of cost growth were unexpected difficulties due to "pure" technical uncertainties, competitive optimism in original contractor estimates, and the lack of urgency which led to schedule slippages.[1] Also in 1962 the Logistics Management Institute (LMI) conducted a study for the Assistant Secretary of Defense (Installation and Logistics) on the subject of control of engineering and design changes. The LMI Study presented the following conclusions: (1) deficiencies in work statement caused significant change actions, (2) buying-in/getting-well was not considered to be a major change management problem, (3) data on contractual and program change was not readily available, (4) cost impact of changes is greater in concurrent situations, (5) some evidence exists that change management techniques in concurrent situations do not recognize certain critical change programs such as slow processing, retro-fit implementation, and effects on support elements, and (6) processing objectives and standards are seldom evident in change procedures.[2]

A 1967 Harvard study by Richard Lorette covered the problems of changes as viewed by Air Force system program directors. In this study, it was reported that Air Force Program Managers cited (1) indecision as to mission concept, (2) change in requirements, including new requirements by using commands, and (3) deficiencies revealed by category

I, II and III tests. Lorette developed the following reasons for growth in system cost estimates: (1) additional requirements, (2) schedule change, (3) low initial estimate, and (4) delayed decisions.[3]

A 1968 Industrial College of the Armed Forces report noted that there were 1226 contract change modifications to the F-111 production contract, which increased the cost of the overall program by approximately $1.8 billion.[4]

The Chief of Naval Material in 1969 conducted a study of contract pricing and cost control problems in the shipbuilding and conversion management system. The study reported the following five change control problems: (1) continued inadequacies in ship contract plans and specifications which require correction by means of mandatory change orders, (2) specifications are sometimes issued which push the state-of-the-art or which have major cost impacts that are not anticipated, (3) changes have been initiated with inadequate knowledge of costs and uncertain plans as to how these changes will be financed, (4) many Navy organizations, through their interaction with the contractor by reason of their technical control of government furnished material and information, may cause changes to a shipbuilding contract which have neither been anticipated nor provided for, and (5) heavy reliance on government furnished plans and specifications in lieu of contractor proposed plans and specifications that are performance-oriented makes the government vulnerable to increases in costs resulting from change orders and claims.[5]

This same report includes eight recommendations concerning the handling of changes in shipbuilding and conversion contracts. They were: (1) ship acquisition project managers should ensure that all decisions impacting upon the cost of a ship would be made within existing established financial authorization or reserves, (2) Naval Ship Systems Command (NAVSHIPS) should replace the then current Change Review Sub-Board with configuration control boards, one of which would be established and chaired by each project manager, (3) NAVSHIPS continue the Flag Officer Change Review Board with revised functions which include over-all guidance and monitorship of the individual change control boards, (4) changes affecting more than one project should be referred to the Flag Officer Change Review Board for approval, (5) all proposed changes to the project or contract or to agreed-to interfaces with systems/equipment would be treated as engineering change proposals, (6) each project manager would have the responsibility for approving or disapproving all Class I engineering change proposals, (7) NAVSHIPS develop a uniform method by which each configuration change board would develop statistics to identify the number and causes of changes, effect of approved changes in terms of cost and/or schedule delay, and the number and types of changes approved, and (8) NAVSHIPS ensure that all new contracts for ships with private shipyards or naval shipyards invoke configuration management requirements.[6]

Probably the most comprehensive study of changes to weapon system acquisition contracts was conducted by James Reece at Harvard in 1970. He conducted an in-depth study of the change process being used in the production of the F-111 aircraft by the General Dynamics Corporation in Texas. Reece noted that the most clear-cut causes for contract changes are engineering change proposals (ECP's) which could be categorized as (1) correction of deficiencies, (2) improvement changes, (3) state-of-the-art advances, (4) value engineering changes, (5) optional accessories, and (6) gold-plating.[7] Reece developed six major conclusions relating directly to contract changes. They were: (1) degree of contractor control over total program costs is lessened as the portion of the total program cost which represents changes to the original program increases, (2) the contractor did not control the work associated with a change as an entity, separate from the original program, (3) the contractor did not maintain records of actual costs to compare with the original estimates on a change by change basis, (4) there are no rewards or punishments clearly related to good or poor contractor change cost performance, (5) overpricing of changes may be a result of conscious management strategy, and (6) collecting change cost is extremely difficult even under a work breakdown system. It was feasible to end up with 234,373 change work packages and job orders on the F-111 aircraft.[8]

In 197[illegible] [illegible]

Reece also presented seven major recommendations concerning contract changes. They were: (1) focus on major changes by establishing unique accounts for the budget and actual costs of each major change, (2) develop benefits for achieving good change cost performance, (3) improve incorporation of changes into the control system, (4) eliminate budgetary discontinuities by distributing change budget through the budget ledgers in a timely fashion, (5) cut down on the number of changes, (6) make changes at pre-determined break points, and (7) earlier negotiation of prices on changes to force the contractor to control costs.[9]

In 1970 Michael Heffron conducted a study for the Center for Naval Analysis concerning cost overruns in the Navy's shipbuilding program. He pointed out the following ten major causes for the large cost overruns in Navy shipbuilding: (1) inadequate planning for the early, firm definition of ships, (2) funding of developmental systems and experimental ships with shipbuilding funds, (3) reducing budget prices of ships below those developed by professional ship cost estimators, (4) inadequacy of specifications, control of change orders and early anticipation of claims, (5) lack of adequate management information and cost control systems for the project manager, (6) unsuccessful control of naval shipyard new construction, (7) failure to balance program decisions with their cost impacts, (8) shortages of manpower at Naval Ships Systems Command headquarters and other shipbuilding and conversion management support activities, (9) inability to forecast accurately the economic conditions in the shipbuilding industry, and (10) reprogramming of apparent excess funds to offset new program requirements.[10]

Another view of the scope of the change problem can be seen from looking at a few pointed statistics. In 1972 a report on the economics of defense spending by the Comptroller of the Department of Defense presented a breakdown to the percentage of the adjusted development estimate for forty-five weapon systems. This summary is presented as Table I. Note that the cost increase shown of $19.8 billion is 22.8% of the adjusted development estimate for the system.[11] Finally, Table II, also published by ASD (Comptroller), shows the total number and dollar amount of contract modifications issued by the Department of Defense during Fiscal Year 1972.

Considering modifications for additional work and change orders, note that 771 change orders or 10.4% of the change orders represented $1.2 billion or 82.9% of the total change order dollars, and that 713 additional work modifications or 5% of the additional work modifications represented $5.2 billion or 80.6% of the total additional work dollars. Change orders over a million dollars represented 69.3% of all change order dollars and additional work modifications over a million dollars represented 80.6% of all additional work dollars. The point being made here is that a small percentage of large changes represent a majority of the total dollars involved.

TABLE I

RELATIONSHIP OF CONTRACT CHANGES TO
% OF ADJUSTED DEVELOPMENT ESTIMATE 1972

Type	$ Billions	% of adjusted development estimate
Engineering Changes	$ 4.2	4.8
Support Changes	1.2	1.4
Schedule Changes	3.5	4.0
Economic Changes	4.3	5.0
Estimating Changes	4.3	5.0
Unpredictable	.5	.6
Other	1.8	2.1
Net Increase	$19.8	22.8%

Source: U.S. Department of Defense. Office of the Assistant Secretary of Defense (Comptroller). THE ECONOMICS OF DEFENSE SPENDING - A LOOK AT THE REALITIES. Washington, D.C.: Government Printing Office, July, 1962, p. 157.

TABLE II

NUMBER AND DOLLAR VALUE OF
CONTRACT MODIFICATIONS - FY 72
(AMOUNTS IN MILLIONS)

SIZE (IN DOLLARS)	MODIFICATIONS									
	SUB-TOTAL		ADDITIONAL WORK		FUNDING ACTION		CHANGE ORDER		TERMINATION	
	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT
$10,000,000 OR MORE	315	$ 7,802	138	$ 3,593	154	$ 3,641	23	$ 568	0	$ 0
5,000,000 OR MORE	520	9,017	210	4,078	267	4,279	39	675	4	14-
2,000,000 OR MORE	1,199	10,797	442	4,808	618	5,111	129	908	10	31-
1,000,000 OR MORE	2,021	11,700	713	5,184	1,042	5,541	243	1,021	23	47-
500,000 OR MORE	3,549	12,533	1,238	5,545	1,764	5,916	497	1,140	50	68-
300,000 OR MORE	5,217	13,029	1,773	5,749	2,594	6,136	771	1,222	75	77-
200,000 OR MORE	6,941	13,337	2,337	5,884	3,401	6,256	1,109	1,278	94	81-
100,000 OR MORE	11,024	13,733	3,620	6,061	5,361	6,411	1,864	1,353	179	92-
50,000 OR MORE	18,000	14,082	6,213	6,242	8,366	6,529	3,070	1,413	351	103-
25,000 OR MORE	27,414	14,288	9,629	6,359	12,369	6,595	4,738	1,447	678	113-
10,000 OR MORE	42,020	14,419	14,285	6,433	19,059	6,635	7,417	1,474	1,259	122-
AVERAGE SIZE (DOLLARS)	$	343,156	$	450,298	$	348,107	$	198,782	$	96,938-
CUMULATIVE PERCENT										
$10,000,000 OR MORE	0.7%	54.1%	1.0%	55.9%	0.8%	54.9%	0.3%	38.5%	0.0*	0.0%
5,000,000 OR MORE	1.2	62.5	1.5	63.4	1.4	64.5	0.5	45.7	0.3	11.7
2,000,000 OR MORE	2.9	74.9	3.1	74.8	3.2	77.0	1.7	61.6	0.8	25.3
1,000,000 OR MORE	4.8	81.1	5.0	80.6	5.5	83.5	3.3	69.3	1.8	38.2
500,000 OR MORE	8.4	86.9	8.7	86.2	9.3	89.2	6.7	77.3	4.0	55.6
300,000 OR MORE	12.4	90.4	12.4	89.4	13.6	92.5	10.4	82.9	6.0	63.5
200,000 OR MORE	16.5	92.5	16.4	91.5	17.8	94.3	15.0	86.7	7.5	66.4
100,000 OR MORE	26.2	95.2	25.3	94.2	28.1	96.6	25.1	91.7	14.2	75.0
50,000 OR MORE	42.8	97.7	43.5	97.0	43.9	98.4	41.4	95.8	27.9	84.0
25,000 OR MORE	65.2	99.1	67.4	98.9	64.9	99.4	63.9	98.1	53.9	92.9
10,000 OR MORE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* LESS THAN 0.05 PERCENT
PERCENTAGES BASED ON THOUSANDS OF DOLLARS.

Source: U.S. Department of Defense. Office of the Assistant Secretary of Defense (Comptroller). MILITARY PRIME CONTRACT AWARDS - SIZE DISTRIBUTION FISCAL YEAR 1972. Washington, D.C.: Government Printing Office, 1972, p. 7.

Another aspect of the research focused on the relationship of configuration/engineering change management to the overall problem of major changes in weapon system production contracts. It was found that around 1964 the Department of Defense recognized major problems in configuration management and as a result developed a coordinated configuration management program that forced the services to provide intelligent and efficient evaluation of engineering changes proposed by the contractor or the government itself.

Since defense contractors submitted over $1 billion in constructive change claims between 1967 and 1971 to the Navy and the Armed Services Board of Contract Appeals, the research looked deeply into the cause of constructive changes, principally in Navy shipbuilding, and investigated actions taken by the Navy to control the continuing occurrence of constructive changes. A constructive change is defined as any conduct by a government representative which is not a formal change order, but which has the effect of requiring the contractor to perform work different from that prescribed by the original terms of the contract. It was determined that there were eight basic types of constructive changes. They are: (1) acceleration of work directed by persons other than the contracting officers, (2) drawings were defective in that they contained errors, omissions, inaccuracies or inconsistencies, (3) government-provided information, documentation or approvals were late, defective or subsequently revised, (4) improper inspection, quality assurance and/or rejection of work, (5) specifications or contract provisions were "impossible to perform" because they require work beyond the state-of-the-art or R&D effort, (6) specifications or contract provisions were "impossible to perform" because of conflicting or erroneous requirements, (7) specifications or contract provisions were unclear in that they were open to more than one interpretation or application, and (8) technical direction by persons other than contracting officers.[11]

It was learned that the Navy, having experienced most of the constructive change problems, initiated several types of remedial steps to alleviate the problem. One effort made was the improvement of preparation of specifications through improving the quality of technical data furnished to contractors. In-process verification and review of technical data was also conducted. In another step, saturation training was conducted by the Chief of Naval Material and by the General Counsel of the Navy in constructive change recognition and contract administration. By Navy Procurement Circular No. 30, contract administration officers were required to maintain a record of significant events for all contracts in excess of $5 million, or where the Supervisor of Shipbuilding determined that a reasonable possibility existed that a claim would be asserted.

In 1969 the Chief of Naval Material established a Claims Control and Surveillance Group for the purpose of reviewing and settling all claims totaling $5 million or more. Also, in 1970, NAVMAT introduced claims identification clauses which attempted to put the government back in control over some of the most significant segments of contract performance.

The direction of this paper now turns toward the report of empirical data obtained from quering the change principals in major weapon system acquisition.

The project manager respondents defined major change as one in which there was a substantial increase or decrease in weapon system capability and/or a change which causes six months or more slippage/stretchout in delivery date. A majority of the project manager respondents felt that major change should be categorized as necessary in viable weapon system acquisition programs. Next, in response to a key question, the project manager respondents reported that the cause of major changes were: (1) changes in operational requirements causing change in the weapon system, (2) change in program direction/funding (except quantity), and/or (3) incomplete plans and specifications at time of contract award. The project manager respondents noted that constructive changes were not a problem in the operation of most of their projects and they strongly agreed that a mandatory pre-pricing requirement for major changes could cause cost growth and/or system delivery delay. The project manager respondents noted deficiencies in the Department of Defense Configuration Management Program and offered suggestions for improvements to the program. They reported efforts made by the services and contractors to control the occurrence of major changes and offered new ideas for reducing or resolving the problem. Some of their more original ideas were: (1) devise a new method for selling and starting an actual weapon system program without having to "oversell" the program and promise a performance/cost/schedule package that will not likely happen, (2) establish a system for better control of change money within the applicable services, (3) move towards a policy of design-to-cost for all major weapon systems, and (4) develop a willingness by the services to accept less than the state-of-the-art product at delivery and accept some obsolesence in new weapon systems.

The contractor respondents defined major change as a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission and/or a change causing twelve months or more slippage/stretchout in delivery date. Like government project manager respondents, the contractor respondents felt that major change was necessary in a viable weapon system acquisition. A majority of contractor respondents felt that the causes of major changes were: (1) changes in program direction/funding (except quantity), (2) changes in the weapon system to update the system to a newly achieved state-of-the-art, (3) changes in operational requirements causing change in the weapon system, and (4) research and development performed in production contracts. A majority of contractor respondents felt that their contracts had experienced constructive changes and reported that configuration management was functioning well in their programs. They noted deficiencies in the present configuration management program and offered suggestions for improvement. The contractor respondents were also of the opinion that mandatory pre-pricing of major changes could lead to cost growth and/or system delivery delay. Efforts they had made to control changes were pointed out and government change control efforts they had observed were presented. Finally, some of the new ideas offered by the contractor respondents for controlling major changes were presented: (1) efforts must be made to control the engineers involved in weapon system acquisition since their training stressed the importance of change for improvement, (2) closer liaison between the weapon system user and the technical community could result in the inclusionof many mandatory requirements in the original specifications, (3) when change money is available it is utilized; therefore some efforts must be made to hide change money until it is really needed, and (4) develop a new type of weapon system production contract that recognizes the occurrence of major changes, and accomodates these type changes more easily and effectively.

Regarding the definition of major change, the contracting officer respondents were in agreement that major change is a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or six months or more slippage/stretchout in system delivery date. A majority of the contracting officer respondents felt that major change should be categorized as necessary in a viable weapon system acquisition. The causes of major change in weapon system production contracts as reported by a majority of the defense contracting officer respondents were: (1) changes to update the system to a newly achieved state-of-the-art, (2) incomplete plans and specifications at time of award, (3) changes in operational requirements causing changes in the weapon system, and (4) changes in program direction/funding (except quantity). A majority of the contracting officer respondents felt that the contracts they had awarded/administered had not experienced constructive changes. Also, a majority of defense contracting officer respondents reported that the Department of Defense Configuration Management Program was functioning satisfactorily. They reported deficiencies in the configuration management program and offered suggestions for its improvement. The defense contracting officer respondents felt strongly that a mandatory requirement for pre-pricing major changes could lead to cost growth and/or system delivery delay. They noted efforts made on the part of the government to control changes, but reported few contractor change control efforts. The defense contracting officer respondents offered the following new or original ideas for resolving or reducing the occurrence of major changes: (1) consider only flight safety changes in aircraft, with all other changes in the next year buy, (2) develop a system to control change money, (3) allow time in production schedules for change impacts, (4) learn to live with major changes, considering that the cheapest and least disruptive change is one that is resolved prior to the start of changed work, and (5) consider model contract experimentation for weapon system acquisition.

A summary of the change principals' ranked responses to the question of causes of major change is provided by Table III.

As a result of the empirical and secondary research conducted, the following conclusions are drawn.

The first conclusion deals with the causes of major changes in weapon system production contracts. Based on the majority opinion of change principal respondents, the causes of major changes, in order of importance, are: (1) changes in operational requirements causing change in the weapon system, (2) incomplete plans and specifications at time of contract award, (3) changes in program direction/funding (except quantity), and (4) changes in the weapon system to update the system to a newly achieved state-of-the-art. A complete summary of the change principals' ranked responses to the question of causes of major changes is provided in Table III.

TABLE III

SUMMARY OF CHANGE PRINCIPALS' RANKED RESPONSES TO QUESTION OF CAUSES OF MAJOR CHANGES IN WEAPON SYSTEM PRODUCTION CONTRACTS

Suggested Causes	RANKINGS 1st	2nd	3rd	4th	5th	Total Times Selected
a. Changes in operational requirements causing change in weapon system	16	9	6	6	6	43
b. Changes in programs direction/funding (except quantity)	8	9	8	5	8	38
c. Incomplete plans and specifications at time of award	13	10	5	5	5	38
d. Changes in weapon system to update system to newly achieved state-of-the-art	7	7	13	4	6	37
e. R & D performed in production contracts	5	4	6	5	5	25
f. Inability of the contractor to meet the requirements of the contract plans and specifications	2	4	3	9	3	21
g. Normal engineering and technical changes	2	7	3	4	5	21
h. Unknowns in production contracts	1	3	3	6	2	15
i. Inability of the government to accurately estimate actual weapon system cost	0	4	5	3	2	14
j. Accumulation of constructive changes	0	2	3	2	4	11
k. Inflation	1	1	3	2	2	9
l. Other	6	1	1	0	0	8

The second conclusion concerns the categorization of major change in weapon system acquisition. Fifty-seven percent of the change principal respondents categorized major change as necessary in a viable weapon system acquisition. Based on the opinion of the experts, this report also concludes that major change is necessary in viable weapon system acquisition, and further concludes that major change should be recognized by Congress, the General Accounting Office and the public as a necessary aspect of weapon system acquisition.

The third conclusion deals with constructive changes. Based on the fact that fifty-six percent of the change principal respondents reported that they had not experienced constructive changes in their programs, and because Table III shows that the suggested cause "constructive changes" was not chosen by change principal respondents as a cause of major changes, it is concluded that constructive changes are not a primary contributor to the occurrence of major change in weapon system production contracts.

The fourth conclusion has reference to the Departmnet of Defense Configuration Management Programs. Since forty-two percent of the change principal respondents reported that the configuration management program was performing satisfactorily and thirty-five percent of the respondents reported that it was performing well, and because a majority of respondents noted that ECP process time standards are being met, it is concluded that the Department of Defense

Configuration Management Program is achieving its objectives in a satisfactory or better manner.

The fifth conclusion deals with the feasibility of pre-pricing major changes before directing the contractor to perform them. Because thirty-two percent of the change principal respondents felt that it would be impossible to pre-price major changes, and twenty-three percent of the respondents felt that pre-pricing of major changes could be accomplished only 25% of the time, it is concluded that it is not feasible to pre-price all major changes prior to directing the contractor to perform them.

The sixth conclusion also deals with pre-pricing of major changes. Based on the opinion of ninety-four percent of the change principal respondents, it is concluded that requirements for mandatory pre-pricing of major changes could lead to cost growth and/or system delivery delay.

The seventh conclusion deals with contractor change control efforts. Because fifty-five percent of the government change principal respondents reported that they observed no contractor change control efforts, it is concluded that many defense contractors are either not interested in the control of major changes, or that their interest in change control has not been demonstrated to government project managers and contracting officers.

The eighth conclusion concerns the Navy's efforts to control the occurrence of constructive changes. Based on the fact that no claims for alleged constructive changes were received during the first three months of 1973, it is concluded that the Navy's efforts in controlling constructive changes have been effective.

Also as a result of the empirical and secondary research, the following recommendations are offered to the government with the belief that they represent possible ways to better control the occurrence of major change in weapon system production contracts: (1) It is recommended that the Office of the Secretary of Defense continue to encourage the use of design-to-cost and prototyping concepts in weapon system acquisition. The change principals have clearly noted that these two concepts help control the occurrence of major changes. It is, however, recognized that these concepts may well have other effects still to be determined. (2) It is recommended that the services develop a specific countervailing force, both in project management offices and within the weapon using commands, to consider the adverse effects of proposed changes. (3) It is recommended that the Office of the Secretary of Defense require that defense contractors develop change-by-change cost controls for those major changes valued at a million dollars or more. It was noted earlier in this report that a few million dollar plus changes represent most of the change dollar expenditures. (4) It is recommended that the services consider a mandatory change freeze at certain points in the production of weapon systems. As an example, changes could be frozen when a ship is 75% constructed. (5) It is recommended that the services develop a system that would avoid revealing the availability of project/program change money. This system would place the government in a better position to negotiate major contract changes. (6) It is recommended that the services, in conjunction with the Armed Services Procurement Regulations Committee, develop a new "changes clause" that would be responsive to the needs of major changes in weapon system production contracts. (7) It is recommended that the Navy follow the lead of the Air Force and Army and require "ceiling" or "not-to-exceed" pricing of changes to weapon system contracts, rather than require mandatory pre-pricing of these changes.

The following recommendations are offered to the defense industry with the belief that the suggestions represent means to better control major changes, to better achieve successful completion of weapon system contracts and to improve customer relations with the government: (1) It is recommended that proposed changes be approved at different levels in the company, based on their dollar value. For example, at Crysler Corporation, proposed changes over $25,000 must be approved by the company program manager and proposed changes over $50,000 must be approved by a division manager. (2) It is recommended that contractors develop a system for maintaining change-by-change cost control on changes valued at a million dollars or over. (3) It is recommended that contractors develop a corporate policy to discourage or resist changes requested in the middle of a production run. Note that the changes clause does not direct when nor where a change must be made. (4) It is recommended that all proposed changes pass into and out of the company through the office of the applicable company project manager. (5) It is recommended that the shipbuilding industry quicken their acceptance and implementation of the Department of Defense Configuration Management Program. The program may be difficult to administer, but it is very worthwhile and sorely needed. (6) It is recommended that defense contractors develop internal procedures for reporting suspected constructive changes promptly to the applicable administrative contracting officer. The disingenuous practice of developing large constructive change claims is very harmful to the weapon system acquisition process and to a company's relations with its government customers.

No paper would be complete without noting that as many questions are raised by the research as are answered. This research effort is no exception. The following topics in the area of major changes are considered to be worthy of additional research. They are: (1) A research effort to locate and determine the cause of delays in processing engineering change proposals. (2) A research effort to determine if it is cheaper to make changes during the production phase or as a retro-fit effort. (3) Research to develop a model contract for major weapon system acquisition. Such a contract could have standard parts and variable parts depending on the weapon system being procured. Research of this type could include new contracting features that respond to major changes. (4) A research effort to determine why some weapon system acquisitions have fewer changes than others. Lessons could be learned from the comparison of a change-prone system with a like change-free system. (5) Further research into the development of regression equations that can be used to predict the rate of cost growth for different types of weapon systems.

It is earnestly believed that the research presented by this paper represents a major effort at determining the causes of major changes in weapon system production contracts and at developing new ideas for resolving or reducing the occurrence of major changes.

References

[1]Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis. (Boston, Mass.: Division of Research, Graduate School of Business, Howard University, 1962), pp. 1-594.

[2]CHANGE MANAGEMENT: Control of Engineering and Design Changes. (Washington D.C.: Logistics Management Institute, 1963), p. 2.

[3]Richard J. Lorette, "The Relationship Between Pressures on the System Program Director and the Growth of Weapon System Cost Estimates." Unpublished dissertation, Harvard University, 1967, pp. 1-422.

[4]Report on Weapon System Management - F-111. Washington, D.C.: Industrial College of the Armed Forces, May 31, 1968.

[5]U.S. Department of Defense. Naval Material Command. SCN PRICING AND COST CONTROL STUDY. (Washington, D.C.: Naval Material Command, April, 1969), p. 10.

[6]Ibid., p. 12.

[7]James S. Reece, The Effect of Contract Changes On the Control of a Major Defense Weapon System Program. Unpublished DBA dissertation, Harvard University, May, 1970, pp. 2-18.

[8]Ibid., pp. 8-26.

[9]Ibid., pp. 8-28.

[10]Michael Heffron, "Heffron Report, September 1970," unpublished report from the Center for Naval Analysis, Washington, D.C.: September, 1970, p. 5.

[11]U.S. Department of Defense. Naval Material Command. Constructive Change Orders in the Navy. Chief of Naval Material memorandum, September 3, 1969, pp. 1-3.

ASSESSMENT

OF

PROJECT IMPACT OF CHANGES.

A. M. Feiler

(To be presented at the 5th Annual DOD Procurement Research Conference, NPS, Monterey, California, November 17-19, 1976.)

CONTENTS

ASSESSMENT OF PROJECT IMPACT OF CHANGES

INTRODUCTION

Successful implementation of configuration management in the Navy depends heavily on the controlling of changes, which on large projects, is accomplished through a complex series of processes within the applicable systems command and involving the Office of the Chief of Naval Operations. The latter, representing the "customers" for the weapon systems, is involved in changes which affect the military characteristics of new ships, changes which would increase the cost of a ship project above the approved Congressional Appropriation, and, any change which would delay a ship beyond contract delivery date.

In NAVSEA, Change Review Board approval is required for proposed changes which have intership class application. Ship Acquisition Project Managers (SHAPM's) approve normal engineering change orders (ECP's) and the Navy Supervisors of Shipbuilding, located at the contractor's yards, have authority to approve ECP's of lesser technical complexity and those that have a relatively small gross cost increase or decrease.

Configuration management has become a serious problem in the acquisition of ship systems. The extremely long lead times between ships conception and fleet delivery coupled with rapid technological development preordains that changes to acquisition project contracts will have to occur during the project or the Navy must face the near certainty of obsolescence upon delivery of the systems. Another contributing factor is the large number of subsystems involved in Navy ship construction.

Accordingly, the Navy has expended considerable effort to limit the number of changes through the adoption of procedures designed to assure more effective change management. For example, during preliminary evaluation of proposed changes, a number of basic questions are raised, covering the necessity, priority, cost, alternatives and impacts on schedules. Key to the evaluation is the "impact analysis" to assess cost and schedule impacts of a proposed change.

Cost and schedule impacts due to a project change may occur at any stage of the acquisition process and, as well, during the ship's operational life cycle. Proper change evaluation should include full assessment of acquisition and life cycle impacts and analysis of the complex tradeoffs between them where appropriate. This paper is concerned primarily with assessment of the impact of project changes on the acquisition process.

IMPACT ASSESSMENT THROUGH NETWORK ANALYSIS

The need to perform project impact analysis occurs frequently during a ship acquisition project. As early as the conceptual development phase and continuing through design and construction, there often is need to assess the overall project impact resulting from

- design and system changes
- budgetary constraints
- technological developments
- delays in decisions
- delays in receipt of information, documentation, materials or equipment
- rejections and returns
- failure to pass tests and trials
- other non-planned action

In the post-delivery phase, impact analysis can be an important assist in the evaluation of contractor claims against the government as well as claims by the government.

One of the frequently used analytical techniques for assessing project impact of changes is based on the use of a project critical path network (project plan).

The project plan can be a direct representation of a project in terms of its depiction of the individual project tasks (activities) which must be undertaken before the project can be completed. The project plan is in effect, a "model" of the project which can be used for problem-solving in a manner similar to use of a system model for systems analysis purposes.

Project network analysis is commonly performed as a routine process by acquisition project management for the purposes of scheduling, budgeting and resource analysis. Also, project networks are analyzed for the purposes of the "What if" gaming of decision alternatives and in particular, assessment of impact of project changes.

SHORTCOMINGS OF CONVENTIONAL CRITICAL PATH TECHNIQUES

Although critical path networks have often provided the analytical framework for project impact analysis, such use has been largely restricted to conventional network analysis techniques which are deterministic, that is, based on single-value inputs.[1.]

It has long been recognized that the use of deterministic network analysis produces erroneous results because of the inability to account for project uncertainties and performance variability and their impact on schedules and budgets.

When project uncertainty and variability are significant (as is usually the case on combatant ship acquisition projects), use of deterministic network techniques invariably results in schedule and budget

1.) See References 1 through 3.

optimism, ranging in some cases to as high as 30 percent.[2]

PROBABILISTIC IMPACT ANALYSIS

Probabilistic network analysis has recently been receiving increased attention for use on projects where uncertainty and performance variability are of significance. Since its relatively recent introduction, the PROMAP probabilistic network analysis technique developed from TRANSIM IV has been successfully applied to a number of Navy ship acquisition, overhaul and repair projects as well as to Navy shore facility construction projects. Among the applications are the following projects:

Ship Acquisition:

- DD963
- FFG-7
- AEGIS

Ship Overhaul and Repair:

- AFS-7
- AOE-4

Shore Installations:

- Bremerton Naval Medical Center
- Travis AFB Hospital
- Port Hueneme Hospital and Clinic
- Elk Hills Naval Oil Reserve

Probabilistic network analysis can produce more accurate results than deterministic techniques because it can account for uncertainty and performance variability. Although such advantages have been adequately demonstrated in project risk management application on current ship acquisition and overhaul projects, the

---

2.) *See Reference 4*

concept of using a probabilistic analysis technique for impact analysis in connection with claims evaluation on an already completed project may raise some eyebrows. One might ask, "What is uncertain about a job already done?"

Effective configuration requires that the impact of a project change be determined by the status of the project at the time of the change. Otherwise, it becomes difficult to isolate and assess the impact of the change itself, because subsequent project changes or actions may eventually obscure its specific cause/effect relationship.

On ship acquisition projects in particular, many of the project tasks in design, fabrication, installation, assembly, outfitting and testing are characterized by a significant amount of uncertainty and variability especially on lead ships. In addition there are the highly uncertain reviews, approvals, changes and decisions of the Navy plus the inevitable change order which can affect almost any phase of the work and occur at any time.

Under such circumstance, *assessment of the impact* of project changes requires taking into account at the time of the changes, the uncertainties and variabilities inherent to all stages of work yet to be accomplished in the ship acquisition process. Otherwise, any attempt to qualify the impact in terms of schedule or costs may produce erroneous results.

EXAMPLE ANALYSIS

An example comparison between deterministic and probabilistic analysis using an activity network representing a ship boiler repair project (Figure 1) shows the following basic differences in results.

Optimism of Deterministic Project Completion Time. The deterministic project completion time for the Boiler Repair Project is 64 workdays which according to the probabilistic analysis, only has a

6 percent likelihood of being attained. The probabilistic expected (average) completion time is 76 workdays, or a 19 percent increase over the deterministic completion time. As discussed in Reference 4 the difference between deterministic and probabilistic results is primarily due to the "merger bias" effect which is not accounted for in deterministic analysis. Such optimism is typical of most deterministic network analyses.

Activity Criticality and Sensitivity. Deterministic network analysis identifies a single critical path. For the Boiler Repair network, the deterministic critical path consists of Activities 04, 08, 13, and 21 (See Figure 1). However, probabilistic analysis reveals that more than one path has the capability of becoming critical during the course of the project. In some cases, the deterministic critical path may not even have the highest likelihood of being critical.

Probabilistic analysis of the Boiler Repair network shows that the path through Activities 04, 08, 11, 23, 24, 26, 27, and 28 has a significantly higher likelihood of being critical than the deterministic path (Figure 2). Other paths are also shown to have a significant likelihood of being critical.

Such a difference between deterministic and probabilistic results can be very important in quantification of the "cause-effect" relationship in impact analysis. For instance, in a deterministic analysis of the Boiler Repair network of Figure 1, a five days' delay to the start of any activity on the deterministic critical path would ordinarily be assumed to have a "one-to-one" impact on overall project performance; i.e., the project completion will be delayed by an aeuivalent five days.

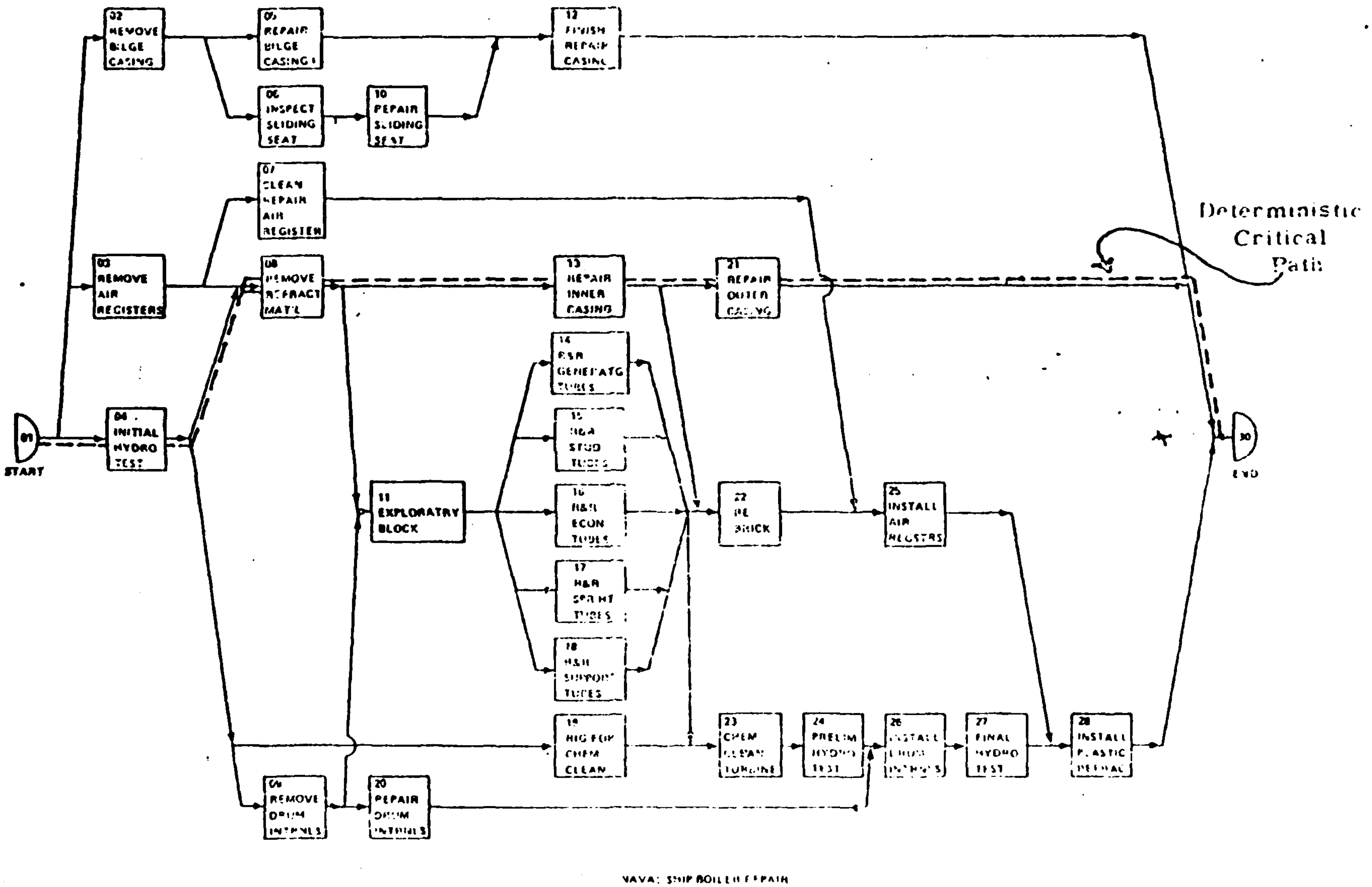
Such is not the case, however, when considering the variability of activity performance of project activities which remain to be undertaken. For example, a five days' delay to Activity 04, Figure 1, is total project performance (See Table II below); while the same delay

TABLE I

BOILER REPAIR PROJECT
(FIGURE I)

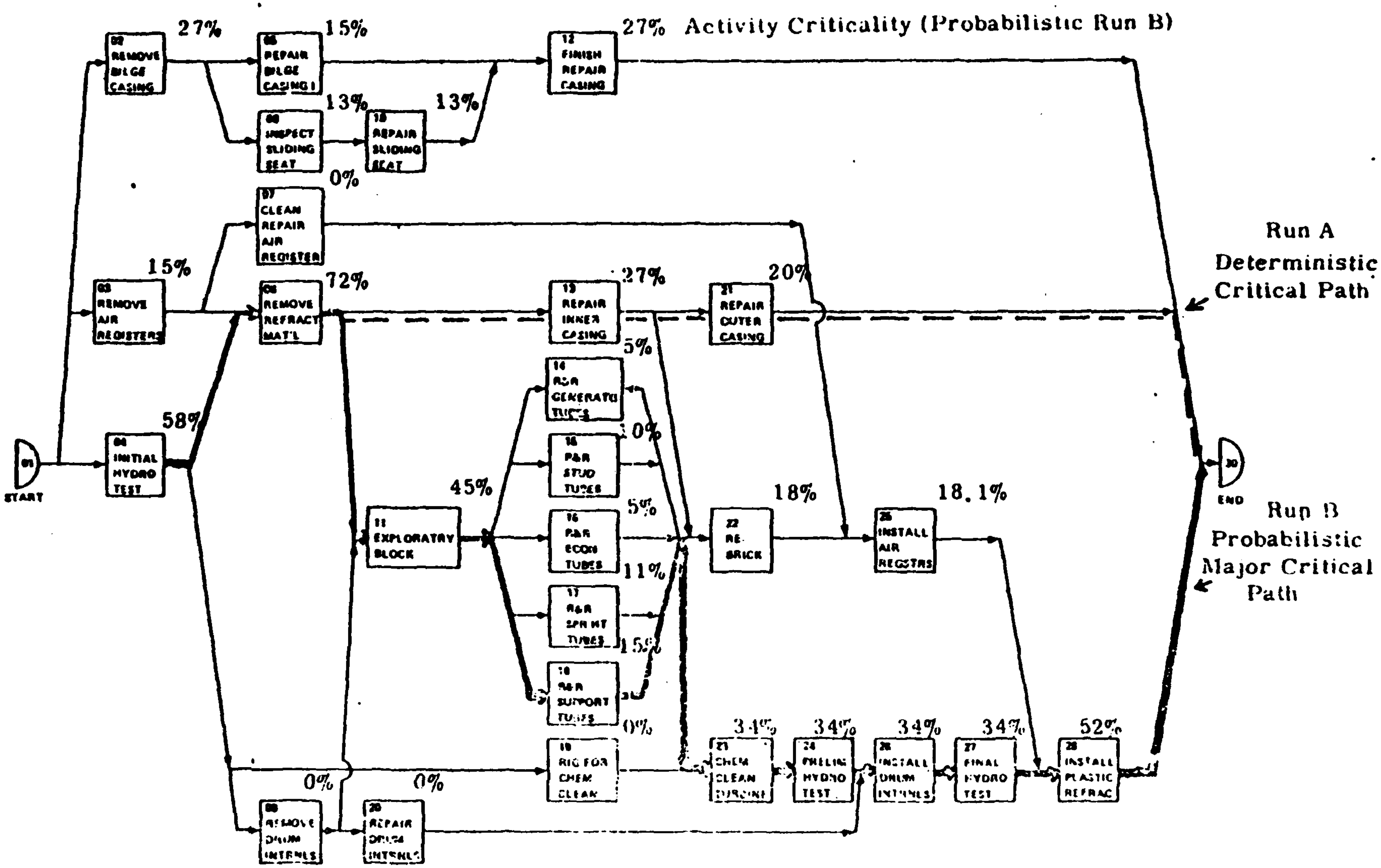
ACTIVITY DURATION TIMES, WORKDAYS

		Probabilistic			
Activity	Deterministic	Optimistic	Most Likely	Pessimistic	Expected
02	11	3	7	20	11
03	2	0.5	1	3	2
04	3	1	2	5	3
05	26	10	20	45	26
06	5	2	5	8	5
07	30	10	30	50	30
08	7	4	5	10	7
09	2	0.5	1	3	2
10	21	8	24	32	21
11	11	7	8	18	11
12	23	10.5	18	39	23
13	37	20	37	54	37
14	20	10	20	30	20
15	20	6	18	36	20
16	21	13	18	31	21
17	21	8	16	36	21
18	21	6	12	42	21
19	10	5	6	17	10
20	12	5	12	18	12
21	17	5	17	29	17
22	7	5	6	10	7
23	3	1	2	5	3
24	6	1	3	14	6
25	6	1	7	10	6
26	6	2	7	8	6
27	2	1	2	3	2
28	1	0.5	1	2	1
29	--	6	10	15	10
31	--	1	3	8	4



Run A. Deterministic Analysis

Figure 1



Critical Path and Activity Criticality
Ship Boiler Repair Project

Figure 2

applied to Activity 13, also on the deterministic critical path, effects only a two days' project impact upon probabilistic analysis.

In a probabilistic network analysis, the ratio of overall project impact to a specific delay to an activity is referred to as the "sensitivity" of the activity or the importance of that activity to overall project performance. The probability that an activity will lie on the critical path is referred to as the activity "criticality."

A typical relationship between activity sensitivity and criticality for the Boiler Repair network example is given on Figure 3. Experience with other project networks ranging from very small to large (over 2,000 activities) shows a similar relationship between activity sensitivity and criticality.

A comparison between deterministic and probabilistic impacts for several Boiler Repair activities is given in the following Table:

Figure 1	Determ. Activity Float	Activity Criticality		Project Impact of 5 Day Delay (Workdays)		
Activity	Workdays	Determ.	Probab.	Determ.	Probab.	Activity Sensitivity
04	0	100%	58%	5	4	80%
08	0	100%	72%	5	4	80%
13	0	100%	27%	5	2	40%
02	20	0%	27%	0	2	40%

TABLE II Comparison Between Deterministic and Probabilistic Impacts for Several Boiler Repair Activities.

In practice, the relationship between activity criticality and sensitivity differs between networks and must be developed separately for each. This is usually done during the early sensitivity runs and then repeated at appropriate times during the project.

For impact analysis in connection with claims analysis on an already completed project, the activity sensitivity relationship can readily be developed "after-the-fact" by reanalyzing the project network, using an original set of data representing the degree of uncertainty and variability existing prior to actual performance of the individual tasks.

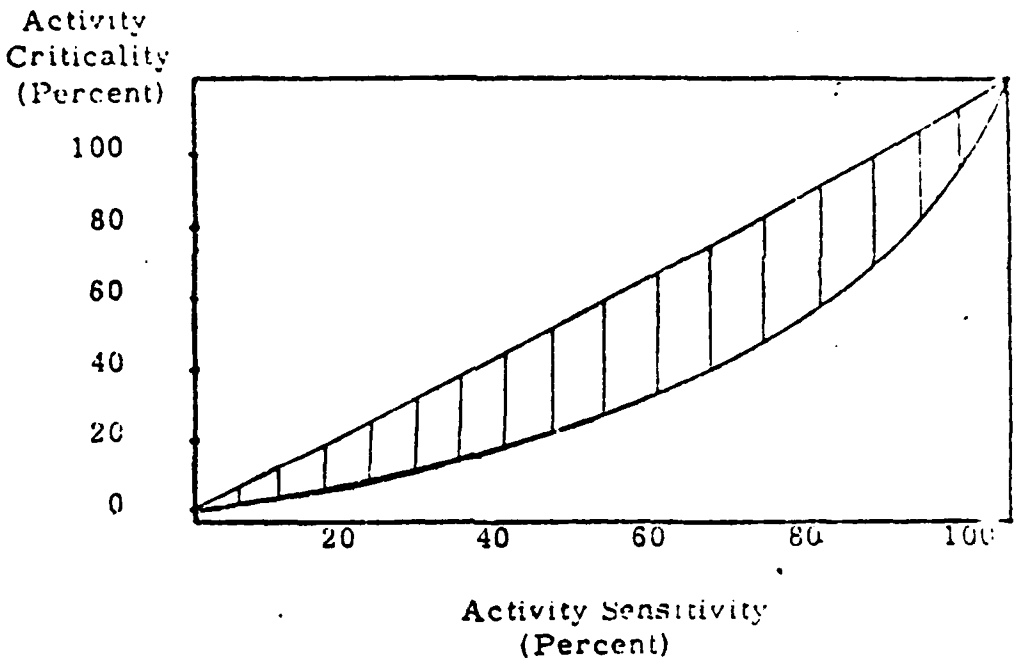


FIGURE 3. Boiler Repair Network: Activity Sensitivity.

Other differences between deterministic and probabilistic network analysis of importance to impact analysis include (See Reference 4):

1) Late Start Bias (which increases activity criticality and therefore, its sensitivity).
2) Ignoring of probabilistic network branches (which increases the optimism of deterministic solutions).
3) Ignoring of probabilistic peak requirements for shipyard scarce resources such as work force, cranes, etc. (which further increases the optimism of deterministic solutions).

REFERENCES

1. Klingel, A. R. "Bias in PERT Project Completion Time Calculations for a Real Network. "Management Science. 13(4): B-194-201, 1966.

2. MacCrimmon, K. R. and Ravec, R. C. "An Analytical Study of the PERT Assumptions." Operations Research. 12 (1): 16-37, 1974.

3. Van Slyke, R. M. "Monte Carlo Methods and the PERT Problem." Operations Research. 11(5): 839-860, 1963.

4. Feiler, A. M. "Project Management Through Simulation." Proceedings: Fourth Annual Procurement Research Symposium. Colorado Springs, October 15-17, 1975.

Socio Economic

- Definition of cost / [illegible] problem.
- Comparability [illegible] regional data base.
  - Need -
    - New analysis
    - Better demographics.

END

FILMED

6-83

DTIC